CIVIL ENGINEERING

MAY 1950

THE MAGAZINE OF ENGINEERED CONSTRUCTION

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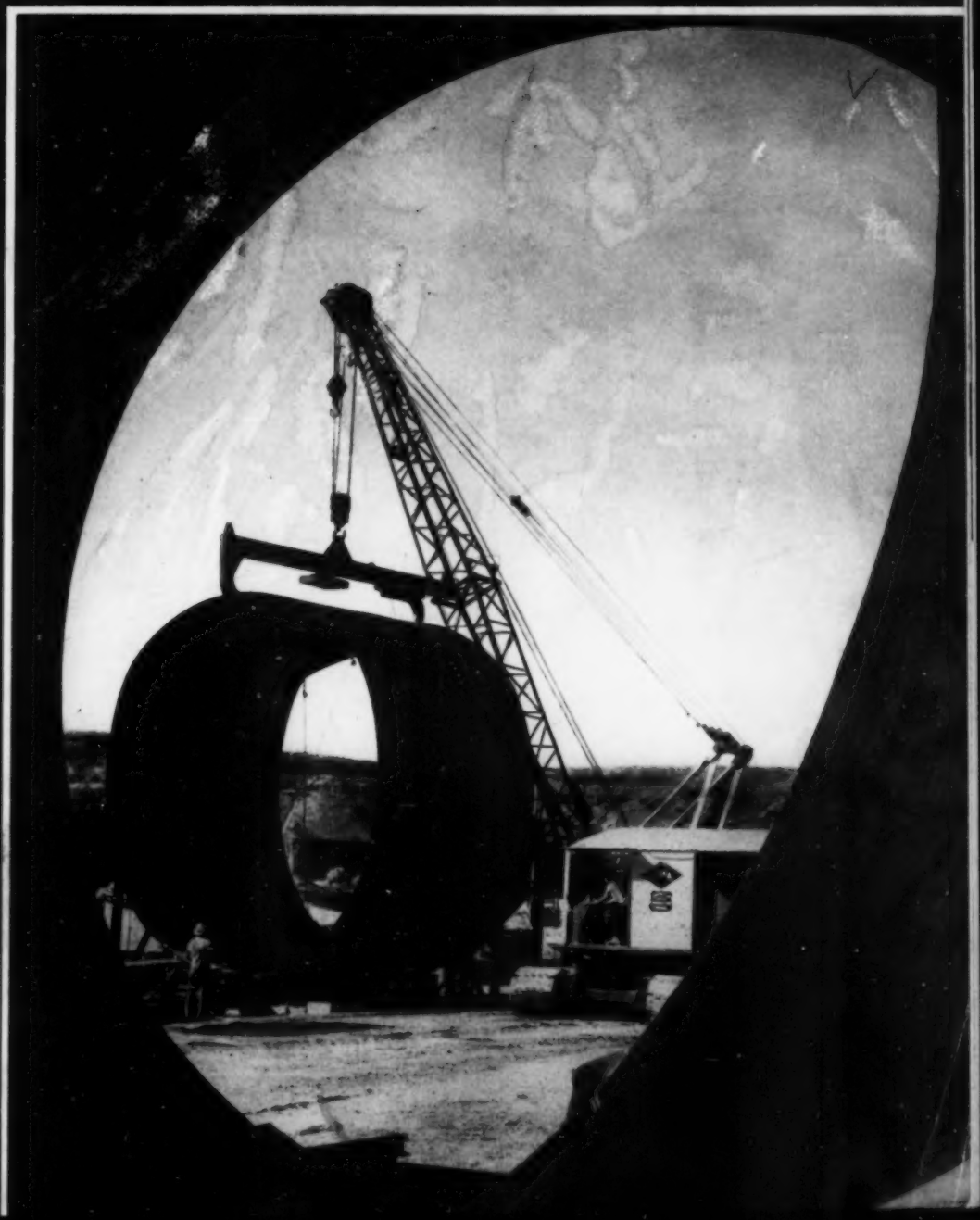
AMERICAN SOCIETY OF CIVIL ENGINEERS FOUNDED 1852



ED STEEL LINER for Soap
Siphon, Columbia Basin
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ticle by A. J. Davidson

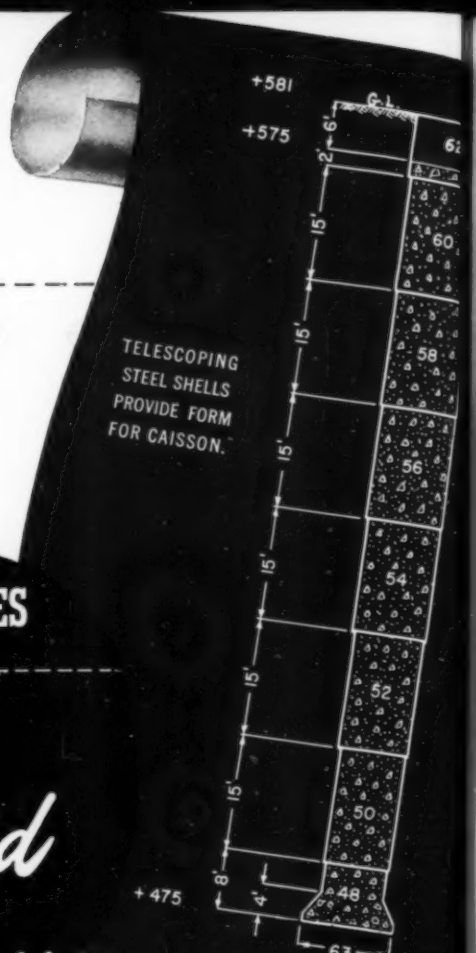
Raymond

MAKES 5 TYPES OF CONCRETE PILES

1. STANDARD . . . 2. STEP-TAPER . . . 3. PIPE STEP-TAPER
4. COMPOSITE . . . 5. GOW CAISSONS

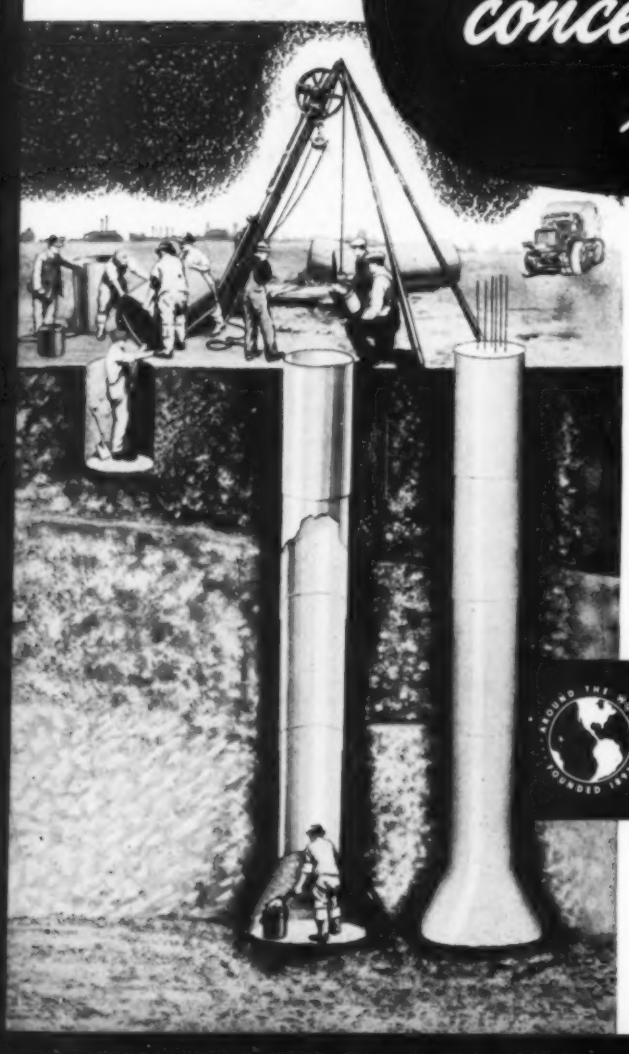
Raymond installs every type of pile: cast-in-place concrete, precast concrete, steel pipe, wood and H-beam. Raymond operations include underpinning, borings and soil investigations, waterfront construction and harbor and river improvements, also cement mortar lining of pipes by the Centriline Corporation, a Raymond Subsidiary.

At left, excavating starting pit and placing first cylinder. At center, excavating bell at bottom of the steel-lined shaft. At right, the completed caisson.



5. GOW CAISSON PILES

For heavy concentrated loads...



Raymond Gow caissons are efficient and economical for supporting heavy concentrated loads under certain soil conditions. The Gow method consists of hand or machine excavation carried on inside of telescoping steel cylinders. Where the caisson rests on hard ground, a bell is usually formed at the bottom to distribute the load over a large area. Where the caisson rests on rock, the bell is usually omitted. After excavation is completed, the steel cylinders are removed as the concrete is poured.

Because heavy equipment is not required and the steel cylinders are re-usable, Gow Caissons are economical in most soils. Your inquiry is cordially invited.

Raymond CONCRETE PILE CO.

140 CEDAR ST., NEW YORK 6, N. Y.

BRANCH OFFICES: Boston, Syracuse, Philadelphia, Baltimore, Washington, Pittsburgh, Atlanta, Miami, Houston, Kansas City, St. Louis, Cleveland, Chicago, Detroit, Salt Lake City, Portland, San Francisco, Oakland, Los Angeles and principal cities in Latin America.

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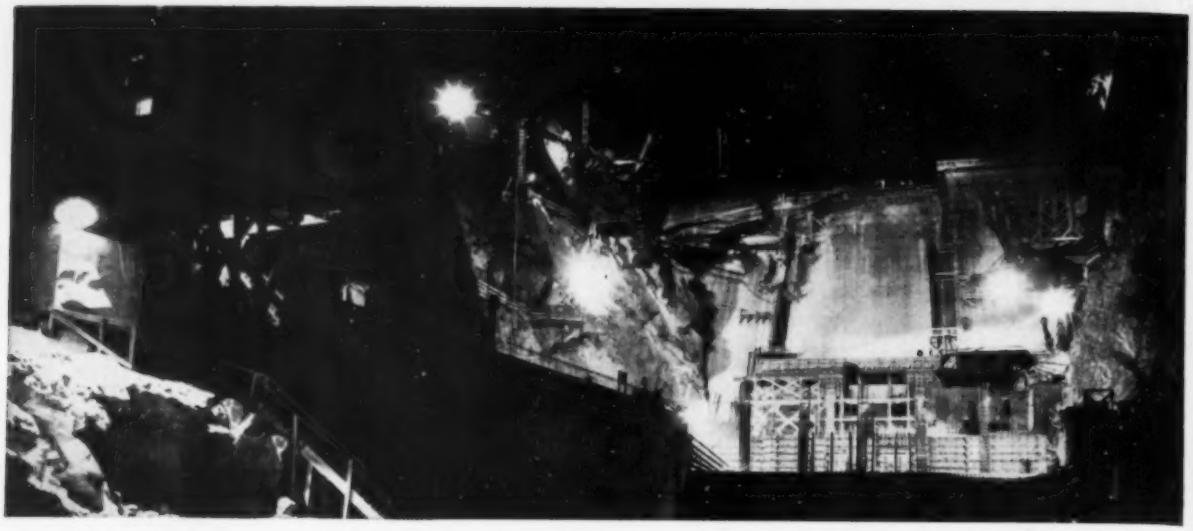
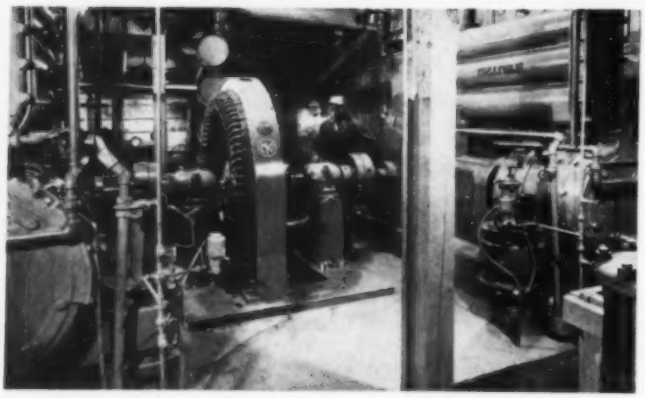
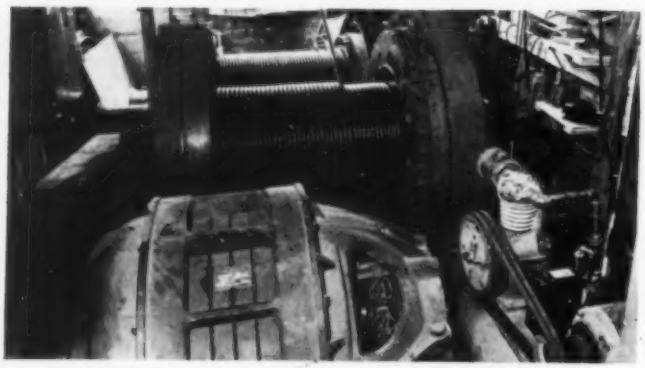


speeding construction at Kortes Dam

... Electrically



All air pressure for job comes from compressors driven by a 500-hp G-E motor.



The 185-foot boom hoist is driven by a 200-hp General Electric induction motor.

G-E Equipment Operates Around the Clock to Meet Schedule

To maintain their rigorous work schedule at the Bureau of Reclamation's Missouri-Basin Kortes Dam project (Kortes, Wyoming), Morrison-Knudsen Co., contractors, must keep on the job 24 hours a day. Thanks to modern machinery *electrified by General Electric*, work proceeds at this accelerated pace without the periodic shutdowns usually expected in this kind of job.

When you electrify with G-E motors and control supplied from G-E power distribution systems, you get safer, faster, more efficient operation. You'll also have the added advantage of engineering assistance in application, installation, and service—regardless of job location. *Apparatus Dept., General Electric Co., Schenectady 5, N. Y.*

Ask him Today!

Whether you buy or build construction equipment, your G-E representative can show you how to do a better job—at lower cost—by complete electrification. Write him now, and he'll call on you at your convenience.

Electrified Construction
BETTER PRODUCT
LOWER COST

GENERAL ELECTRIC

664-9

The New INTERNATIONAL TD-24

HERE'S WHAT THE

Positive all-weather starting on gasoline, with quick change-over to full diesel operation, all from the seat.

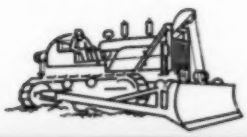
Separate reverse lever for quick change of direction. The tractor moves in the direction the lever is moved.

Self load and run with scrapers of 17-yard capacity—and shift gears on-the-go with the rolling load.

Cut waste shifting time out of work cycles; provide the best speed for every operation, 8 speeds in each direction!

INTERNATIONAL HARVESTER

INTERNATIONAL



24

CHAMPION of Crawlers

"The TD-24's work right along on slopes so steep we have to cut them down before other tractors can climb them even without loads," says Bob Rardin of Rardin Brothers, Akron, Ohio. "They are fast tractors, easy to shift and have plenty of power. This combination really moves dirt." His TD-24 was equipped with a bulldozer.

"It will out-buck any tractor I've ever run," says Harold Wooley's operator, Drain, Oregon, "and sure push dirt up hill—and climb steep grades." His TD-24 works regularly on 30% to 50% grades, building mountain roads.

"I wouldn't have anything else," says another Oregon operator. He works for V. R. Russell & Sons of Valsetz. "It's sure fine on bulldozing; best dirt mover I ever got hold of."

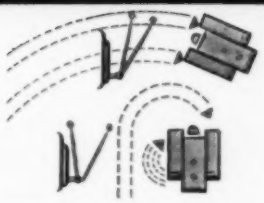
That's the way owners and operators talk about the International TD-24 Crawler. It has earned their praise, for it does everything any other big tractor can do, *plus many things that NO other tractor can do*. The TD-24's versatility makes it the most useful and profitable earth-mover in any equipment line-up.

Visit your International Industrial Power Distributor for a demonstration. Then ask yourself how long you can get along without this big red worker and the extra earnings it will produce.

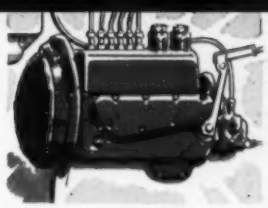
INTERNATIONAL HARVESTER COMPANY
Chicago

HE TD-24 CAN DO FOR YOU

Instant speed change up or down one speed, or stop, without declutching. Planet Power drive does it!



Planet Power steering puts turns with power on both tracks, feathered turns and pivot turns at your fingertips.



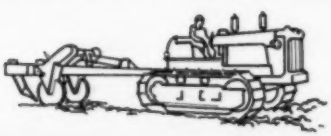
Torque Control feature of fuel injection pump increases engine torque when needed to overcome overloads.

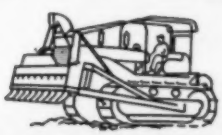
Work on grades up to 100%. Its power, ground contact, balance and lubrication are right for licking any grade.

Handle heaviest loads on gradual turns as easily as straightaway because both tracks are powered in the turn!

Push or pull through tough going. The engine delivers extra "power" when its r.p.m. is pulled down by load.

L INDUSTRIAL POWER





PAY LOADS THAT PAY OFF

★ **New Mexico**, near Silver City. Two "Caterpillar" D8 Tractors push-and-pull-loading a "Caterpillar" No. 80 Scraper with 11½ yards of tough rock in a trifle over a minute—thanks to matched equipment and 130 honest drawbar horsepower. On 800-ft. one-way hauls the hauling team averaged 8 trips and 90 pay yards an hour. Total excavation (5.6 miles) 130,000 yards—about 60% rock. Two other "Caterpillar" Diesel Tractors, with Scrapers and Bulldozers, were also used on this work.

QUICK, big, constant loads . . . they spell SPEED, VOLUME, PRODUCTION. And it's the tractor that plays the biggest part in the pay-off. You get the very tops in results when you sign up the *power, capacity* and *dependability* that "Caterpillar" Diesel Tractors offer—the kind you see working on the state highway construction project pictured above. ★

Says Contractor O. D. Cowart: "From my experience, 'Caterpillar' Diesel Tractors are unbeatable. Their ability to take punishment with a minimum of repairs makes them the leader in the construction field."

That's putting it broadly. It's *sustained slugging power* that counts. Like the prize fighter who can stay on his feet round after round, it's the tractor which day after day can "take it and give it" that's the real profit maker in the long run. "Caterpillar" Diesel Tractors are made of that kind of stuff. They're tough! They don't need "long counts" (down time). They're quick on the comeback . . . should a new part or a fix-up be in order, there's efficient and quick-acting dealer service standing by. "Caterpillar" leaves nothing undone toward building — and keeping — 60-second minutes, 60-minute hours, 24-hour days of *fighting performance* into every unit that bears its name. *Ask your "Caterpillar" dealer for the proof — in mechanical evidence, in user experiences, in demonstrations.*

CATERPILLAR TRACTOR CO., PEORIA, ILL.

CATERPILLAR
REG. U. S. PAT. OFF.
DIESEL
ENGINES • TRACTORS
MOTOR GRADERS
EARTHMOVING EQUIPMENT

Strength factors of Long Life !

No pipe that is provably deficient in any of these strength factors should ever be laid in city streets

BURSTING STRENGTH

In full length bursting tests standard 6-inch cast iron pipe withstands more than 2500 lbs. per square inch internal hydrostatic pressure, which proves ample ability to resist water-hammer or unusual working pressures.

SHOCK STRENGTH

The toughness of cast iron pipe which enables it to withstand impact and traffic shocks, as well as the hazards in handling, is demonstrated by the Impact Test. While under hydrostatic pressure and the heavy blows from a 50 pound hammer, standard 6-inch cast iron pipe does not crack until the hammer is dropped 6 times *on the same spot* from progressively increased heights of 6 inches.

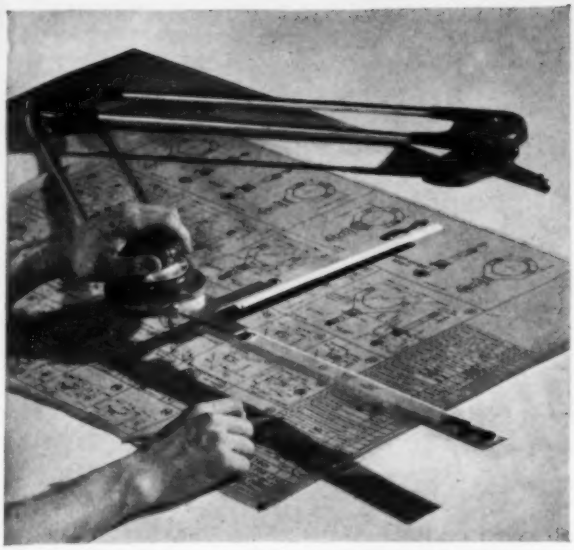
CRUSHING STRENGTH

The ability of cast iron pipe to withstand external loads imposed by heavy fill and unusual traffic loads is proved by the Ring Compression Test. Standard 6-inch cast iron pipe withstands a crushing weight of more than 14,000 lbs. per foot.

BEAM STRENGTH

When cast iron pipe is subjected to beam stress caused by soil settlement, or disturbance of soil by other utilities, or resting on an obstruction, tests prove that standard 6-inch cast iron pipe in 10-foot span sustains a load of 15,000 lbs.

SERVES FOR CENTURIES

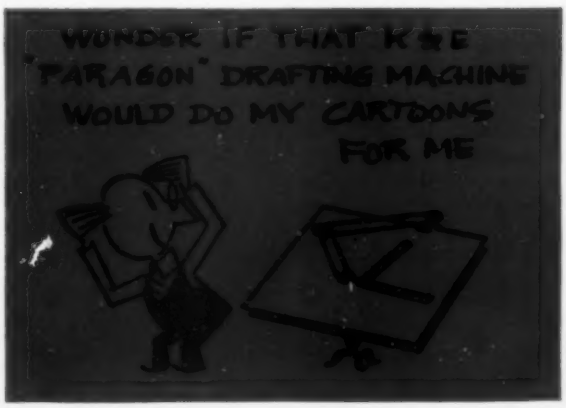


it's twice as fast as "human" drawing

You wouldn't try to be Rachmaninoff without a piano, or a Kreisler without a fiddle. Well, who would want to be a draftsman without a K&E PARAGON† DRAFTING MACHINE?

This miracle machine makes you a veritable orchestra leader at your drawing board. It combines T-squares, triangles, protractors and scales, all in one unit, controlled entirely by one hand.

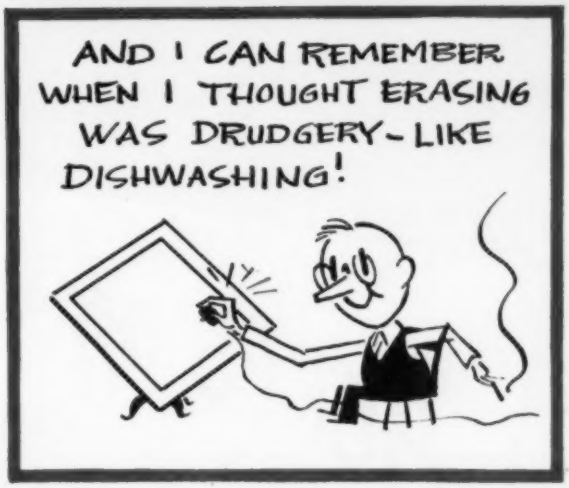
You can move a rule all over the board, and the rule stays parallel to its original position. You can draw all lines to exact length. The lightest touch rotates the scales to any angle desired.



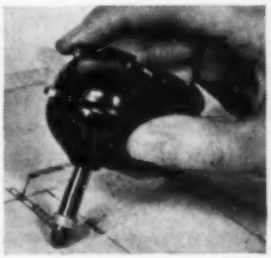
Permanent accuracy is assured, because the open center arm construction makes it practically impossible to disturb the factory-set band tension.

†Trade Mark ®

this whee-e-eraser saves time and elbow grease



This K&E MOTORASER* makes old-fashioned hand erasing look horse and buggy. It reduces your erasing time to seconds.



Since it depends on speed rather than pressure, the MOTORASER does not wear holes in paper. It's as accurate as a pencil point, yet will clean large areas in a jiffy.

It's handy in the hand—a 3 inch palm full with a finger-tip switch—only 6 oz. Uses AC juice —60 cycle 110 volt AC—or DC with an inexpensive adapter. A sturdy little feller, too.

*Trade Mark

For further information about any of the above products, ask a K&E Distributor or any K&E Branch, or write to Keuffel & Esser Co., Hoboken, N. J.

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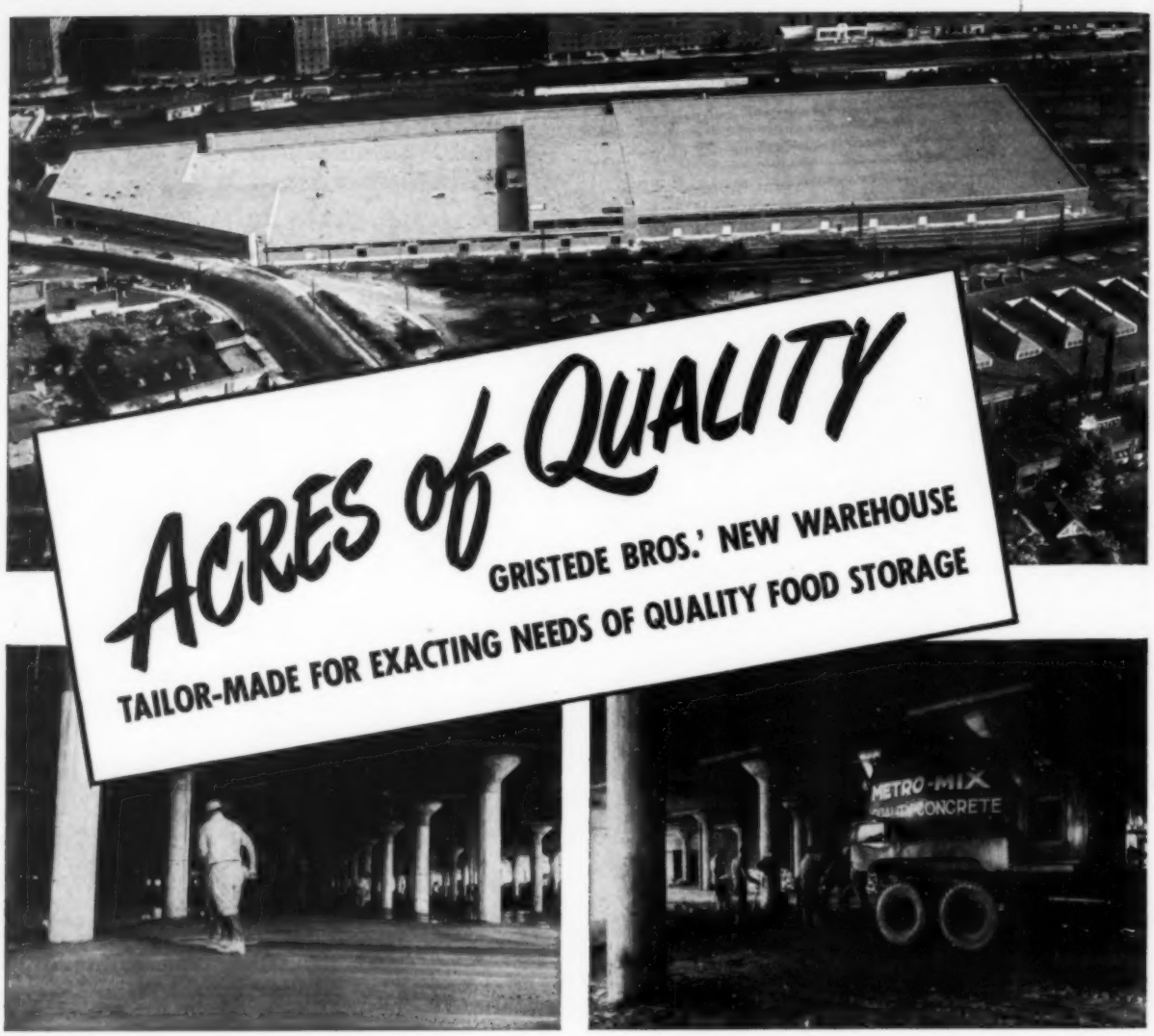

ACRES of QUALITY

GRISTEDE BROS.' NEW WAREHOUSE

TAILOR-MADE FOR EXACTING NEEDS OF QUALITY FOOD STORAGE

● Gristede Bros. Inc. have 140 stores in and around New York City. Each store carries 5,000 items, twice as many as average food stores. Assemble and distribute that many items, provide special storage conditions of temperature and moisture . . . load and unload . . . handle and convey . . . stack and unstack —and you need a lot more than just four walls and a roof! Gristede's new warehouse—355,000 sq. ft. floor area, all heavy-duty concrete construction—is tailor-made to meet these multiple problems. Specialized know-how in design and construction, including concreting throughout with Lone Star Cement, 26,000 bbls., invests this new warehouse with the same "Quality and Service" attributes which have distinguished Gristede operations for the past 59 years.

GRISTEDE BROS. INC.: Warehouse and Offices
Bronxdale near Tremont Ave., Bronx, N.Y.C.
Architect: **OFFICE OF DAVID LEVY,** New York
Contractor:
CARISTO CONSTRUCTION CORP., Brooklyn, N.Y.
Ready-Mix Lone Star Concrete:
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LONE STAR CEMENT, WITH ITS SUBSIDIARIES, IS ONE OF THE WORLD'S LARGEST CEMENT PRODUCERS: 15 MODERN MILLS, 27,500,000 BARRELS ANNUAL CAPACITY

MAY 1950
VOLUME 20 NUMBER 5

CIVIL ENGINEERING

THE MAGAZINE OF ENGINEERED CONSTRUCTION

• *In This Issue*

• *Society News*

• *News Briefs*

• *Departments*

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Lithographed on stone by James E. Allen

U.S. cast iron PIPE

FOR WATER, GAS, SEWERAGE AND INDUSTRIAL SERVICE

Cast iron pipe is tough, husky, but not exactly handsome. What it lacks in eye appeal it makes up for in dependable quality. To see that our product's reputation for quality is lived up to—and to strive for still higher quality—this Company has made substantial investments in facilities for *quality control* and for *research and development.* The recently completed Research Laboratory and Developmental Foundry at Burlington is an important contribution to a long-range program of process and product development. **United States Pipe and Foundry Company, General Offices: Burlington, N. J. Plants and Sales Offices Throughout U. S. A.**

AT MOUTH of San Diego River, recreational potentialities of Mission Bay are in process of being realized. Bay receives silt deposited by river in flood. Improvement project, indicated by white lines, includes flood-control channel for river to keep silt out of bay, and separate harbor entrance from Pacific Ocean, as well as dredging of bay area and building of bridges and recreational facilities.

San Diego Plans $26,000,000 Playground

Mission Bay Area to Be Dredged and Transformed Into Multi-Million-Dollar Tourist Attraction

GLENN A. RICK
City Planning Director, City of San Diego, Calif.

SAN DIEGO is embarking on a $26,000,000 program to develop its most valuable resource—an almost perfect tourist-attracting recreation site. The project will transform Mission Bay from a shallow tidal basin to a multi-million-dollar aquatic park and small-boat harbor. The present area of the bay, 2,400 acres, will be reduced to 1,900 acres, of which 200 acres will be dredged to a depth of 20 ft and the remaining 1,700 acres to a depth of 8 ft, measured at mean low tide.

Wide Variety of Recreational Facilities to Be Provided

Recreational facilities to be developed include those for fishing, bathing, boating, sailing, and such non-aquatic sports as golf, tennis and riding. These facilities will be developed on 1,700 acres of publicly owned property surrounding the bay. Recreation and park land will be improved by filling and landscaping.

Such a large investment would be unwise unless some protection were provided to prevent silt from the San Diego River in flood from refilling dredged areas of the bay. To this end a flood-control channel is being built which will divert the flow of the river from Mission Bay, discharging it directly into the ocean. The channel, 3.3 miles long, with an invert width of 800 ft, will be able to carry 115,000 cfs.

Three echelons of government are involved in the project: the Federal Government, the State of California, and the City of San Diego. The Federal Government, through the Corps of Engineers, U.S. Army, is spending over $10,000,000 on the project, currently estimated by the Corps to cost $26,800,000. Federal expenditures will include: (1) Three rock jetties (nearly completed) costing about $2,250,000; (2) harbor dredging and filling; (3) harbor revetment; (4) floodway construction; and (5) alterations to a railroad bridge. The State of California is contributing to the project through the provisions of the 1945 Flood Control Act. Over a million dollars has already been appropriated by the state, and the city is currently asking an additional $920,000 for the project for next year.

The City of San Diego is responsible for the construction and alteration of highway bridges, utility relocations and extensions, some harbor dredging and filling, some bulkheading and revetment, side drainage structures, lands and damages, and recreational development. To date the city has spent about $3,500,000 and is considering a bond issue of $2,000,000 additional.

Seven Bridges Affected by Project

Six highway bridges and one railroad bridge are affected:

1. Morena Boulevard Bridge, now two lanes wide and 416 ft long, which

LONG JETTY in center foreground, seen in recent air view, divides future Mission Bay harbor entrance, left, from flood-control channel for San Diego River, right. When project is completed, flood-control channel will extend in straight line to join river, out of picture at right.

SHALLOW TIDAL BASIN formed by Mission Bay is at present of little use for recreation. Improvement project envisions long stretches of sandy beaches, 200 acres of water 20 ft deep and 1,700 acres of water 8 ft deep.

on completion will be four lanes wide and 1,110 ft long. Plans for this bridge are now being drawn.

2. Santa Fe Railway Bridge, which will be raised 4 ft and extended from a present length of 400 ft to 930 ft. The sho-fly to handle traffic while the bridge is being rebuilt is under construction.

3. Bridge carrying U. S. Highway 101, a four-lane concrete structure handling a large amount of traffic daily, which will be raised and extended in length from 640 to 940 ft. Plans have been completed and work is scheduled for completion by December 31, 1951.

4. Midway Drive Bridge, which is under construction, work having started in January 1950. It is four lanes wide and 1,000 ft long and will cost $1,081,000.

5. Sunset Cliffs Boulevard Bridge, which will take the place of the old bridge at the mouth of the bay. The new bridge will be about 3,000 ft upstream to permit traffic to flow around the small-boat harbor rather than block the harbor entrance as the present bridge does. The new bridge will be four lanes wide and about 1,000 ft long.

6. The new Ventura Boulevard Bridge, to be constructed of steel and concrete, with a clearance of about 50 ft. The estimated cost is $2,000,000. The present bridge at the site is a temporary steel and timber structure with a clearance of about 30 ft.

7. A bridge, to be built on the proposed Bay Boulevard, which will cost about $210,000, and is the smallest of the seven structures.

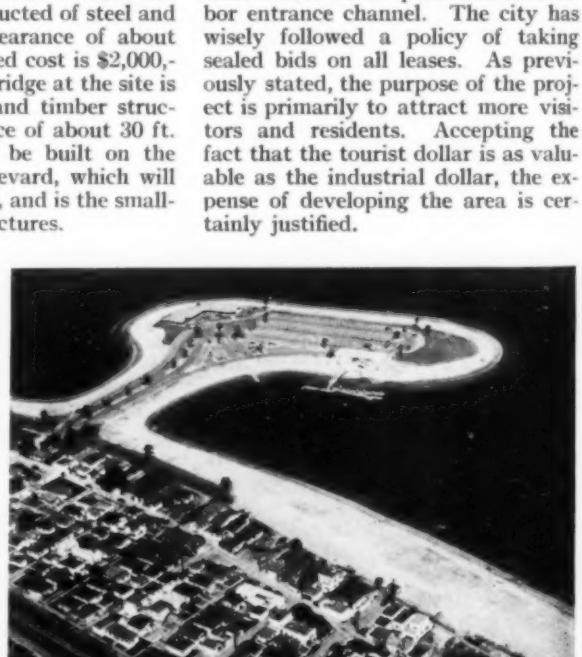
It may sound as though the project is composed only of bridges and a flood channel. True, these items are an important and costly part of the job but the project has many other phases. The city will dredge 20,000,000 cu yd and the Army Engineers 9,000,000 cu yd. This large amount of spoil will be put to excellent use. Some of it is used to create islands and peninsulas in the bay itself. Part is being deposited along the adjacent ocean beaches to replenish the sandy beaches. The remainder is being deposited on hundreds of acres of swamp land to raise it above high-tide overflow, thus creating usable park and recreation areas.

Water and sewer lines, as well as other utilities, must be extended to the newly created areas. Construction of roads, parking lots and landscaping is now in progress along with the dredging. Piers and boat landings are being built as the need develops.

Recreational and Residential Areas Separated

All areas which attract large numbers of visitors were kept as far as possible from built-up residential areas. That is why peninsulas and islands were built in the bay.

The possibility of providing areas for revenue has not been forgotten. Thus far the city has leased only a few areas, some for revenue and others for convenience to the public. This phase of the work is only in its infancy but is growing and will at least double on completion of the harbor entrance channel. The city has wisely followed a policy of taking sealed bids on all leases. As previously stated, the purpose of the project is primarily to attract more visitors and residents. Accepting the fact that the tourist dollar is as valuable as the industrial dollar, the expense of developing the area is certainly justified.



SANTA Clara Point, one of new recreational peninsulas built in Mission Bay, affords ample parking space. Islands and peninsulas keep visitor-attracting features as far as possible from established residential areas, and at same time provide for disposition of dredged material, which will also be utilized for filling city-owned land adjoining bay, to be developed for recreational use.

Do Bankers Need Engineers?

Yes, Answers Prominent Banker in Address Before Engineering Economics Division at ASCE Los Angeles Meeting

A. J. GOCK

Chairman of the Board of Directors, Bank of America, Los Angeles, Calif.

SCIENCE AND TECHNOLOGY have made such great advances in the past quarter of a century that every industry and nearly every business have problems with technological aspects which bear on successful and profitable operation. Bankers are no exception to the rule. In their role of aiding the development of business and industry in the community, they are with increasing frequency encountering scientific and technological problems, but few bankers have the necessary background and experience to interpret these problems intelligently or to appreciate their economic implications. It is in this connection that they need the assistance of engineers.

Good Banking Promotes Community Welfare

In a narrow sense bankers are in the business of loaning money. In a broad sense, however, banks and bankers do more than merely supply funds for business and industrial operations. Because we are living in a credit economy, and because borrowed money is essential to the development of the community and to the conduct of business operations which are carried on therein, intelligent banking can do a great deal to encourage sound community development. It can probably do more than any other one service to aid in the establishment of the proper type of enterprises in a community and in guiding such enterprises along a sound course.

The first concern of the banker in making a loan is to make sure that both principal and interest will be paid when due. The terms of the loan—interest rate, security required, amount of the loan, time allowed for repayment—are all largely controlled by this matter of risk.

Factors which determine the magnitude of the risk are both tangible and intangible in character. With short-term loans, tangible factors usually predominate. In the case of long-time loans, intangible factors are more apt to predominate. Such factors include unforeseen obsolescence, new developments or techniques, changes in price levels or production costs, shifts in management, changing public tastes or local conditions. These factors will operate not within a matter of months, but rather over many years. Amortization of principal may increase the security behind the loan with time, but on the other hand unforeseen factors such as those just enumerated may reduce the security at a more rapid rate than amortization decreases the principal. The best protection a banker can have in setting up the terms of a loan is an intelligent knowledge of the tangible and intangible factors that affect risk. The risk assumed should be what military men term a "calculated risk."

Now what have engineers to do with bankers except to deposit money with them and to borrow money from them—if possible? In doing these things engineers are using the services of bankers, although perhaps not as much as they should. But I wonder also if bankers are using the services of engineers as much as they should and could, and if not, whether the fault may not lie primarily with engineers.

Where Does the Engineer Come In?

When I speak of bankers using engineering services, I do not mean for the design of a building, construction of a water system, or other work of this character in which the banker may be involved. The services of engineers which I have in mind are those that might be of value to bankers in the conduct of their banking business.

Engineering technologists have their proper place in industry and business, but the engineers who might be of service to bankers are those whose viewpoint and experience would be of value in this problem of evaluating such things as community needs, and the quality of risk involved in various types of loans. I have in mind engineers who have retained their knowledge of engineering fundamentals but have added to it mature judgment, vision and a sound knowledge of materials, men and money. Such engineers are not plentiful. A major purpose of this presentation is to encourage younger engineers to give thought to the broadening of their studies and reading beyond the narrow scope of their job or specialty into the broader fields of economics, history, finance, management, politics and people.

Engineering Analysis Needed in Banking

As a general thing, engineers have had a specialized type of training which involves the solution of problems. An engineer is called in to design and build a bridge over a river. The basic problem is the need of communication across the stream. The solution is the building of the bridge, which involves its design and construction, which in turn create a series of subsequent problems that must be solved.

The engineer's training is of the type that produces an analytical mind. He is interested in trends and relationships. For example, when a banker desires information on a certain subject, he likes to have it presented to him in the form of a set of figures, which he studies to arrive at a conclusion. An engineer will take a similar set of figures, but he will work them up in the form of charts or graphs, and from these he will not only reach a conclusion, but in addition will develop information regarding trends and relationships. This habit tends to develop the engineer's powers of analysis to a high degree.

It is for these reasons, I believe, that a potential market exists for the services of engineers, not alone among bankers, but among business men in general. To develop this market, the engineering profession will have to develop engineers who have the proper qualifications; it will have to improve its product in other words, and likewise will have to sell it. Development and improvement will probably be more difficult than selling.

Broader Application of Engineers' Talents

If more engineers will seek to develop the abilities and qualifications needed by business, industry and finance, their technological work will also be greatly improved. Planning, designing, and constructing things involve more than merely using the laws and forces of nature for the benefit of mankind. These activities also involve the use of money and an understanding of people. I hope that there will be increasing interest in this application of engineering talent.

Man-Made Rivers Enrich the West

Enormous Projects Often Require Joint Efforts of Several Large Contracting Firms

NATURE DISTILLS from the sea and deposits on the land in the form of rain and snow more water than man has ever been able to put to beneficial use. This process is complicated by uneven distribution. In the arid and semi-arid regions of the West the problem is one of handling and controlling too much water in wet localities, storing it in wet seasons for use in dry seasons, transporting it from areas of overabundant supply to those less favored, preventing flood damage, conserving it for maximum use and reuse, and finally, extracting kilowatts of power from it as it flows back to the sea.

Rivers, unharnessed, tear through cities, threaten human life, flood valleys, destroy crops and wash fertile soil into the ocean. Under control, western rivers furnish power for big industrial operations, irrigate millions of acres of valuable food crops, encourage home building, and increase the nation's wealth.

Both government and private utility engineers are engaged in the comprehensive development of the total water and power potentialities of western rivers on a basin-wide scale for agriculture, industrial and domestic use. These river control structures are huge in size. Dams, canals, tunnels, powerhouses, transmission lines, and pumping plants rival each other in size, length, capacity and in usefulness to the economy of the western states. Engineers and contractors tax their ingenuity to reduce costs by developing better design and construction procedures, larger and more efficient equipment.

Because of the West's special interest in water, a considerable part of this issue is devoted to reporting how several of the large western water conservation projects were planned and are being constructed. The following six articles are based on papers in the symposium, "Rivers of the West—Man Made," presented before the Construction Division and before its joint session with the Power Division at the Society's Spring Meeting in Los Angeles.

On the Colorado River, engineers of the Bureau of Reclamation are planning a billion dollars worth of multi-purpose dams. When developed, Bureau engineers estimate that the 5 million kw hydroelectric potential of the river will be a paying partner in defraying costs of the irrigation works on the river. Construction of one of the units—Davis Dam on the lower Colorado—is described.

In California the Southern California Edison Company is completing the comprehensive power development of the 500,000-kw power potential of Big Creek, a tributary of the San Joaquin River; the Pacific Gas and Electric Company is building 300,000 kw of hydro plants on tributaries of the Sacramento River; and the Bureau of Reclamation is completing its $400,000,000 Central Valley Project to transfer Sacramento River water to the San Joaquin Valley for the irrigation of fertile acres.

In the State of Washington, construction is under way to pump 16,000 cfs of water from the reservoir behind Grand Coulee Dam to irrigate a million acres in the Columbia Basin. The story of the construction of canals and pipelines to conduct this water to the land—conduits which rival natural rivers in size—completes this résumé of man-made rivers of the West.

Power Can Be Paying Partner in Colorado River Development

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WHERE ARE WE now in our development of the water resources of the Colorado River? The primary function of the Bureau of Reclamation is to help build a firm western economy through the development of irrigated agriculture. Steps in this development associated directly with the Colorado River are river regulation, flood control, irrigation, power, silt control and correlative recreational advantages.

Geographically and by interstate compact, the Colorado River watershed is divided into the Upper and Lower Basins, the dividing line being those mountain divides which delineate the drainage area above Lee Ferry, as shown in Fig. 1. The 110,000 sq miles above Lee Ferry contributes 16,270,000 acre-ft to the average annual virgin flow of the stream; the 132,000 sq miles below Lee Ferry and above the International Boundary contributes 1,450,000 acre-ft. Thus the upper 45 percent of the drainage area contributes 92 percent of the stream's net virgin water production.

Water Allocated to Upper and Lower Basins

There are two fundamental categories of water use—consumptive, as transpiration from vegetation and evaporation from reservoirs; and non-consumptive, as the use of water to turn turbines. As to consumptive use, the Upper Basin is entitled to 7,500,000 acre-ft of beneficial consumptive use annually, subject to the qualification that it shall not cause the flow of the river at Lee Ferry to be depleted below an aggregate of 75,000,000 acre-ft over any period of ten consecutive years. It is now depleting the flow at Lee Ferry by an annual amount of the order of 2,000,000 acre-ft, and projects authorized or under construction will increase this depletion to 2,500,000 acre-ft. Thus the Upper Basin may be said to be perhaps one-third along with its water-use development.

Stated simply, the Lower Basin is entitled to the delivery at Lee Ferry of an average of 7,500,000 acre-ft annually, and it has the additional right to increase its consumptive use by 1,000,000 acre-ft per annum. At about this point the subject of water becomes controversial in the Lower Basin. At the present time the effect of man's operations in the Lower Basin is the depletion of the Colorado River at the International Boundary by 4,900,000 acre-ft annually.

In the Upper Basin, 1,350,000 acres are irrigated, an area equivalent, roughly, to the State of Delaware. In the Lower Basin, 1,860,000 acres are irrigated, equivalent roughly to the combined areas of the States of Delaware and Rhode Island. These areas represent a large segment of the economies of the basin states.

Five major cities of the Southwest look to the Colorado River and its tributaries for water supply: Phoenix, in the basin, for the whole of its water supply; Denver, Los Angeles, and San Diego, for a part of their present supplies and for the needs of future growth; and Salt Lake City for future needs. Denver, particularly, is planning great works for the diversion of Colorado River water.

Los Angeles and San Diego are members of the Metropolitan Water District of Southern California, which has financed the construction of Parker Dam, on the Colorado River, and has built, to half ultimate capacity the Colorado River Aqueduct, 242 miles long, at a cost of some $200 million. Construction of a branch aqueduct to San Diego was undertaken by the Navy as a war emergency measure, under plans prepared by the Bureau of Reclamation and completed by the former agency under a repayment contract with the San Diego County Water Authority.

Silt? The river carries it in quantities that stagger the imagination and as yet no means have been found for doing much about it. A lot of silt is being stored in Lake Mead now, but there is a lot of room for it there. Upstream developments coming along in the future, notably Glen Canyon, will pick up the burden in time. Lake Mead can carry the burden temporarily—say for 100 years—without Glen Canyon. In the meantime the sedimentation problem should be tackled at its sources in the interest of conservation of land resources.

Hydro Power Potential Undeveloped

Turning now to the subject of hydroelectric development, so far the Upper Basin has developed about 52,000 kw at 22 plants. Two plants—the Green Mountain Plant of the Bureau of Reclamation, with 21,600-kw capacity, and the Shoshone Plant of the Public Service Co. of Colorado, with 14,400-kw capacity—account for 36,000 of the 52,000-kw total. The other 20 plants are of course much smaller. Development of the hydroelectric potential of the Upper Basin obviously is not far along.

In the Lower Basin, hydroelectric development is well along. Hoover power plant has installed, or in process

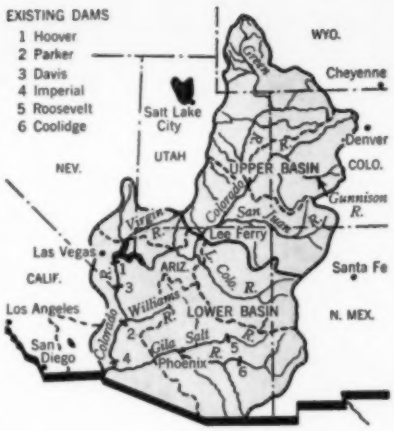


FIG. 1. Upper Basin of Colorado River, covering 45 percent of drainage area, produces 92 percent of river's net virgin waters.

of installation, a capacity of $1\frac{1}{4}$ million kw and a firm energy output of about $4\frac{1}{4}$ billion kwhr a year.

About 65 miles below Hoover Dam, the Bureau of Reclamation is constructing Davis Dam and power plant. An installation of 225,000 kw here will generate about 1 billion kwhr a year. About 88 miles below Davis is Parker Dam and power plant. The installation there is 120,000 kw, and the generation about $\frac{3}{4}$ billion kwhr a year. A short distance below Parker Dam is Headgate Rock Dam, the diversion works for the Colorado River Indian Reservation. Ultimately, 30,000 kw will be developed at this location, with energy generation of about $\frac{1}{8}$ billion kwhr. The main stem of the Colorado River may be said to be fully developed, as to head potentialities, from Hoover Dam downstream. The drops on the All-American Canal are now partially developed by two separate installations totaling 24,000 kw.

In the Gila River Basin, about 71,000 kw have been developed in eight hydro plants on the Salt River and the canal system in connection with the Salt River Project, and 10,000 kw at Coolidge Dam on the Gila River in connection with the San Carlos Project in Arizona. Other minor hydro developments in the Lower Basin total about 7,000 kw.

In summary, a total of about 1,750,000 kw of hydroelectric capacity, with an annual production capacity of about 7.2 billion kwhr, has been developed or is under construction in the Colorado River system. The studies of municipal and private utilities and of the Federal Power Commission, are unanimous in pointing out the serious need for further hydroelectric development on the river to the extent that such development is economically sound. It is the Bureau of Reclamation's purpose to meet that need as it makes plans for maximum use of our water resources and as it executes those plans.

Dozen Hydro Sites Planned for Construction

Planning data are not complete but it is known that there are at least 29 sites in the Upper Basin with power potentials that warrant investigation. On the basis of present knowledge, the installation of about 2 million kw and an annual generation of about 9.5 billion kwhr is indicated. In the Lower Basin, at least 9 sites offer promising possibilities; these would have a combined installation of about 2 million kw and an annual generation of about 10 billion kwhr. The total prospect for the basin is 38 sites with an installed capacity of 4 million kw and an annual generation of about 19.5 billion kwhr.

Planning has advanced to the point where the key reservoirs and hydro plants are well defined. The Upper Basin has the right to use beneficially 7.5 million acre-ft a year, and a concurrent obligation to deliver to the Lower Basin at Lee Ferry an average of 7.5 million acre-ft a year. The Upper Basin can make full use of the water apportioned to it only if it provides long-time holdover storage to meet its Lee Ferry obligation. Compatible with the operation of reservoirs for river regulation is the generation of electric energy to satisfy the market demand. The net revenues from the electric energy can be used to pay for the holdover storage capacity without which full development of the water resource cannot be attained, and to assist individual irrigation projects which deserve a helping hand.

Tentative Sites Selected in Upper Basin

My counterpart in the Upper Basin, Regional Director E. O. Larson, has submitted to the states of the Upper Basin for review, and has received approval of, a plan for developing 10 large dams and reservoirs in the Upper Basin. In their aggregate, these would provide 48 million acre-ft of reservoir capacity, including capacity provided for sediment deposition; and hydroelectric capacity of 1.7 million kw for generating 9 billion kwhr annually. The sites tentatively selected are shown in Fig. 2.

To give an idea of the physical dimensions of the works proposed for the Upper Basin, two of these works will be described—the Echo Park and the Glen Canyon units. The Echo

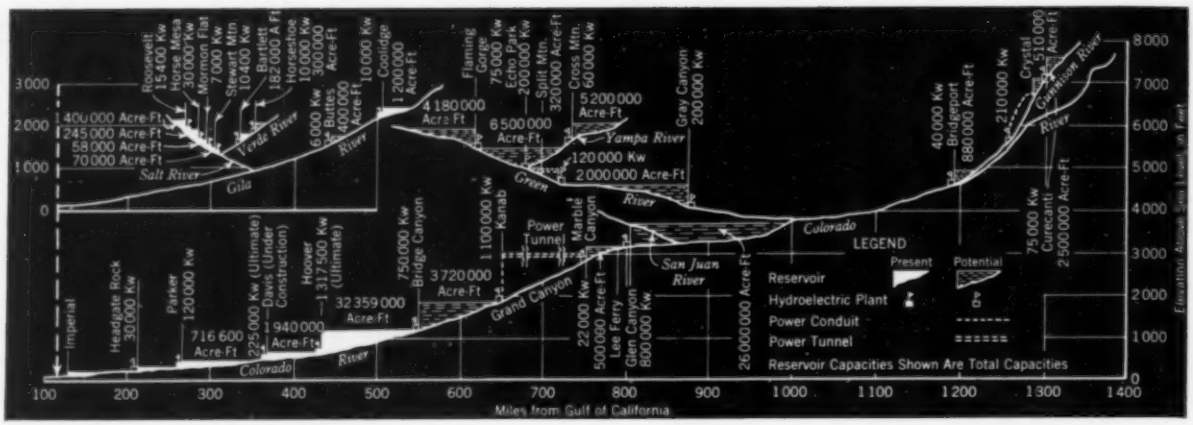


FIG. 2. Existing and proposed sites for dams, reservoirs and power plants on Colorado River would develop full power capacity and create ladder up to junction with Green River. Largest of these reservoirs, Glen Canyon, would have ability to capture sediment over 200- to 300-year period, to store 26,000,000 acre-ft, and to provide for installation of 800,000 kw of hydro capacity.

Park Unit is ideally situated to supply the immediate needs of the Upper Basin power market. The site lies within the Dinosaur National Monument, so that its submission to Congress for authorization is contingent upon a policy decision as to this encroachment upon a national monument. A curved concrete gravity-type dam, with a crest length of 900 ft, rising 525 ft above the river bed, would command 6.5 billion acre-ft of reservoir capacity. By way of physical comparison, Hoover Dam rises 588 ft above river level and has a crest length of 1,244 ft. The power plant at the base of the Echo Park Dam would contain five units of 40,000 kva rating each, and would have an annual output of approximately 1 billion kwhr. In addition to its important functions in river regulation and power generation, the reservoir would yield substantial benefits in the way of sediment retention, recreational facilities, and fish and wildlife enhancement. Echo Park Reservoir would be among the most economical of those proposed as regards the relationship between evaporation and storage capacity.

Glen Canyon Site Studied

The Glen Canyon site, about 15 miles upstream from Lee Ferry, is the lowest storage site available in the Upper Basin. Fortunately it appears to be adequate physically in that upwards of 30 million acre-ft of reservoir capacity could be developed there. The Bureau's studies, not yet final, show economic justification for at least 26 million acre-ft of reservoir capacity. To attain that capacity a dam 565 ft above the river would be required. At present a hydroelectric installation of 800,000 kw is envisioned and an annual production of 4 billion kwhr.

It will be observed that Glen Canyon would provide the major holdover storage for satisfying the Lower Basin entitlement at Lee Ferry, and that its energy production would be most significant in the economy of this southwestern area. In its ability to capture sediment over a period of 200 to 300 years without substantial impairment of its full potentialities, Glen Canyon would add substantial value to the power sites downstream from it but above Lake Mead.

Undeveloped Sites in Lower Basin

The problem in the Lower Basin is not so complex as to physical facilities. Farthest upstream in the Lower Basin, but not necessarily earliest in prospect, is the Marble-Kanab site, also shown in Fig. 2. At this site, in Marble Canyon well outside the Grand Canyon National Park, a concrete arch-gravity dam about 300 ft high is contemplated, to back water to the toe of Glen Canyon Dam. A gravity tunnel approximately 45 miles long and 36 ft in diameter would divert out of Marble Canyon Reservoir, pass under the Kaibab Plateau north of Grand Canyon National Park, and terminate about 1,250 ft above the Colorado River at Kanab Creek, below the park.

A power plant at the river level would have an installation of 1,100,000 kw and would generate about 6¾ billion kwhr annually. To maintain a live stream through Grand Canyon, 1,000 cfs would be released through a 22,000-kw hydro plant at Marble Canyon Dam. Marble Canyon Reservoir would have no substantial regulating capacity, but seasonal and carry-over river regulation would be provided by Glen Canyon Reservoir.

At the head of Lake Mead, and 118 miles upstream from Hoover Dam, is the Bridge Canyon site. Here another concrete-arch, gravity-type dam rising 673 ft above streambed is contemplated. A dam of this height would develop substantially all the head between Lake Mead and Kanab Creek, and would command a reservoir of 3,720,000 acre-ft. A power plant at this site would have an installation of 750,000 kw and a firm energy production of about 4.4 billion kwhr.

Existing projects, together with those just discussed, would create a virtual ladder on the Colorado River from the mouth of the Gila River to very near the junction at the Green and Colorado Rivers. The Echo Park and Glen Canyon developments are parts of this ladder, and planning for them is under way.

The present estimate of the Colorado River Basin's hydroelectric potential is about 5 million kw, now 40 percent developed. Expressed in kilowatt hours, this is 16 billion kwhr, now 45 percent developed.

The Bureau's objective is full economic use of our water resources. Happily, there apparently is opportunity for full development of the economical irrigation opportunities and a correlative major development of hydroelectric energy. Most of the great reservoir works mentioned are required for irrigation, either directly or indirectly. Irrigation alone cannot build these works, but if it takes in a paying partner—power—repayment of costs can be accomplished.

Construction of Davis Dam Adapted to Foundation Conditions

H. F. BAHMEIER, M. ASCE

Construction Engineer, U.S. Bureau of Reclamation, Davis Dam, Nev.

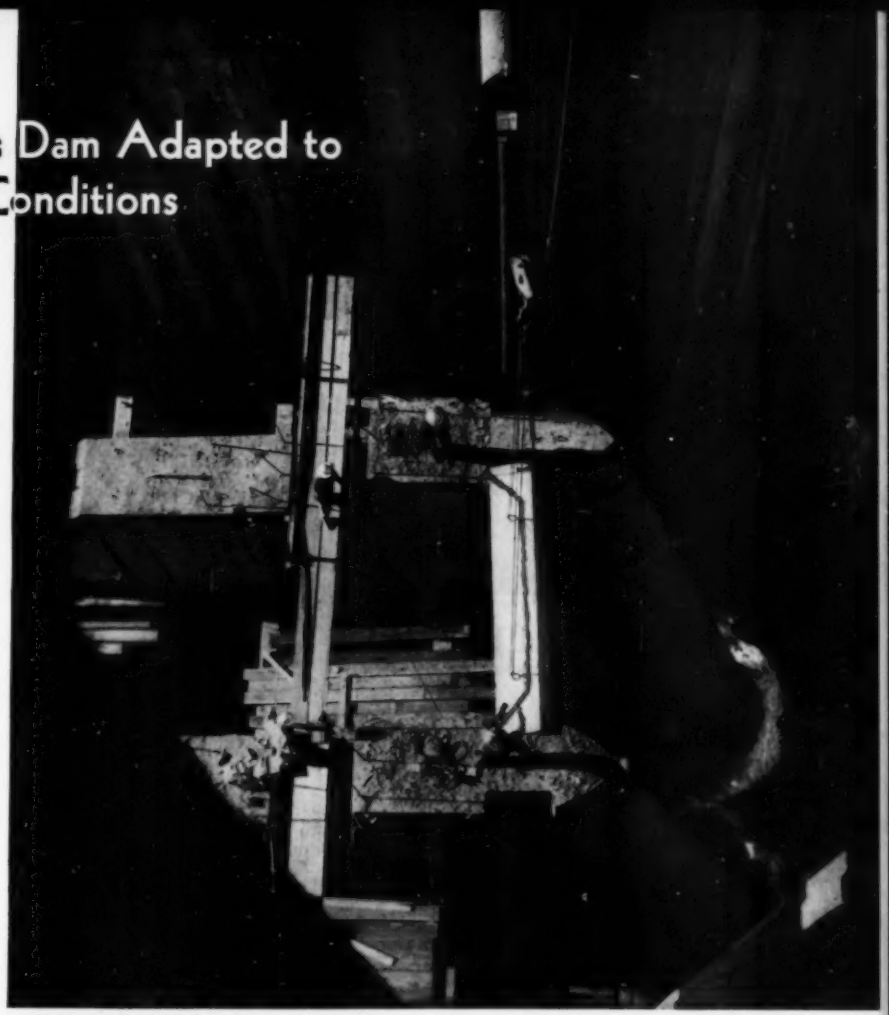
DAVIS DAM, the first large dam on which the Bureau of Reclamation started work after the end of the war, is now essentially complete. From the time ground was first broken, in March 1946, a large diversity of problems attributable to geology, climate and material shortages (in the early postwar period), necessitated design changes to meet unexpected field conditions.

Project Has Three Main Purposes

The principal purposes of the project are: (1) to reregulate the river in coordination with releases from the Hoover Dam power plant; (2) to service the Mexican Water Treaty, which apportions the water of the Colorado and Tia Juana Rivers and of the Rio Grande between the United States and Mexico; and (3) to produce hydroelectric energy. The power plant will generate from 800 million to 1 billion kwhr annually to meet increasing demands in Arizona, southern California, and southern Nevada. The project will provide additional benefits such as recreation facilities, silt-pollution control, and wildlife protection.

The principal features are the dam and appurtenant spillway and outlet structure, hydro power plant, switchyard, and some 900 miles of power transmission lines with incidental substations and facilities. Involving 570,000 cu yd of concrete and 3,700,000 cu yd of earth embankment, it is the largest undertaking on the Colorado River since Hoover Dam. At full reservoir, the headwaters from Davis Dam will rise to the same elevation as the tailwaters from Hoover Dam. The cost of the dam and appurtenant structures is expected to reach $69,000,000, excluding the transmission lines.

The downstream half of the diversion channel, located in rock, was designed for a bottom width of 75 ft and $\frac{1}{2}$:1 side slopes paved with an 18-in. thickness of concrete. As excavation progressed, it became apparent that the rock did not improve with depth. Numerous faults appeared, and large masses of rock, loosened by blasting in adjacent areas, slid down the slopes along bedding planes.



CONCRETE STOPLOG is lowered into slots in upstream end of temporary diversion piers during secondary diversion at Davis Dam on Lower Colorado. Secondary diversion, which forced water through outlet openings after embankment was finished, permitted completion of second and third spillway bays.

Excavation became extremely hazardous, indicating the possibility that the channel might be blocked by rock slides after diversion of the river. Since such blocking would cause great damage, the downstream channel was changed to a 50-ft bottom width with 1:1 slopes throughout the rock cut. The upstream channel required no change.

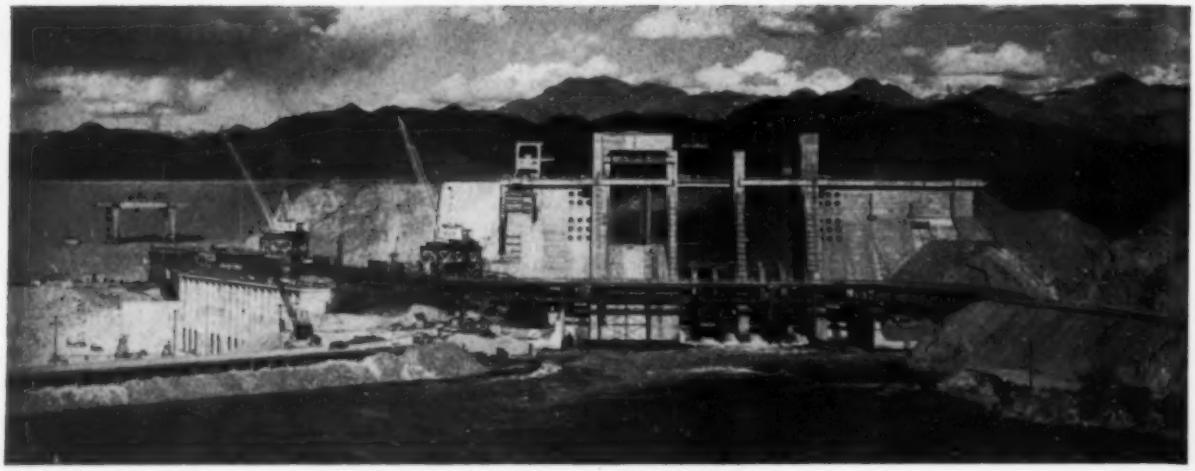
The proposed slope paving, except in the vicinity of the principal structures, was eliminated. The paving now extends about 300 ft upstream from the spillway on the left slope and covers the curved slope upstream from the intake structure on the right side of the channel.

A pneumatically applied mortar lining was placed on certain weak zones of rock as protection against erosion during the diversion period. The lining, 6 in. thick, is reinforced with a 6-in. mesh of No. 10 wire, and is anchored to the rock by $\frac{5}{8}$-in. round reinforcing bars set 3 ft into the rock on 6-ft centers. Steel pipes of 1-in. diameter were embedded through the lining as required to carry off seepage.

Two Other Features Affected

Flattening of channel slopes affected two other construction features. The first, a single-span bridge across the diversion channel, to carry the Arizona–Nevada highway which runs across the top of the dam, was redesigned as a continuous two-span steel plate-girder bridge 420 ft long, supported at the center by a concrete pier 150 ft high. The second, the proposed switchyard area, was encroached upon to such an extent that the switchyard had to be moved to a location about 1,000 ft to the east of the spillway.

The slopes of the diversion channel now appear to be stable, with only minor sloughing in regions not protected by concrete slope paving or



ARIZONA ABUTMENT and spillway structure of Davis Dam near completion. Davis Dam, first large dam on which Bureau of Reclamation started work after second World War, will complete development of Colorado River below Hoover Dam. Earth-fill dam runs to left.

pneumatically applied mortar. The original optimistic design assumption that the rock might stand on $\frac{1}{2}$:1 slopes did not prove expensive. The cost of the additional excavation required was offset by the saving due to the reduction in the quantity of slope paving.

Spillway Crosses Minor Faults

The spillway location, it was found, crossed minor fault lines, decayed zones, and at least one erosion notch. One fault was found at the upstream toe of the spillway, another crossed the downstream end of the bucket section, and a third crossed the area between the other faults at approximately the upstream third of the foundation. The rock exposed immediately downstream from the spillway structure was soft and badly fractured.

A review of these conditions led to the conclusion that the upstream portion of the spillway should be thickened 30 ft and extended upstream about 50 ft.

The intake structure is founded on some of the best rock in the area. The rock contains many fractures but is harder and more massive than that under the spillway and power plant. Since the top of the upper shear zone lies at depths varying from 50 to 100 ft below subgrade, it is believed to present no serious hazard. However, to decrease the load on the power plant site, the intake structure was pivoted from its original position on a point about at its junction with the spillway and power plant (Fig. 1) so that its north end is farther from the river and closer to the forebay channel than it was in the original design. The area was heavily grouted.

Excavation at the north end of the power-plant structure, as shown on the original plans, stopped in what later proved to be the shear zone previously described. However, since this zone dips away from the river, it appeared unlikely that a slide would occur. Since by a system of expansion joints, each of the five power-plant units had been designed as an independent structure, the possibility of differential settlement under one or more units did not constitute a serious objection to the site. Additional fault-zone material, at the northerly end of the power plant area, and extending downstream a distance of approximately 100 ft, was excavated to a depth roughly corresponding to the lower limit of the upper fault zone. This additional excavated area was backfilled with mass concrete. Except for additional grouting, no other important changes were made in the original design of the project.

Penstocks Were Completely Redesigned

Shifting the location of the intake structure increased the length of some of the penstocks and made a complete redesign necessary. The original plan called for the concreting of the penstocks at the same time as the intake structure. Since the time necessary to prepare the new design drawings and fabricate the penstocks would have delayed the construction, the intake concrete was placed with octagonal blockouts to provide for subsequent installation of the penstock sections. The circular sections of steel penstock pipe were later moved

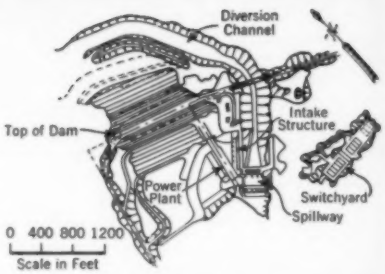


FIG. 1. PLAN of Davis Dam shows final positions of earth fill, concrete intake structures, and switchyard.

on a steel track into their proper position, from the downstream end of the blockout openings. After the penstock sections had been placed and welded together, the blockout was filled, by pumping methods, with concrete containing aggregate of $2\frac{1}{2}$ in. maximum size. When the blockout concrete had thoroughly cooled, the joints between it and the original mass concrete were pressure grouted.

The penstock sections were fabricated at the site. All joints were made by electric welding and were X-rayed before acceptance.

Considerable preparatory work was performed before the river was moved out of its natural bed. After the excavation for the diversion channel and forebay had been completed, concrete was placed in the diversion wall at the upstream face of the intake structure and in the spillway to a height sufficient to accommodate a flow of 60,000 cfs through the six 13-ft-wide diversion openings.

The Arizona end of the upstream cofferdam was constructed with waste materials from required excavation and extended approximately 150 ft into the river. A pile trestle, with 3-ft 6-in. slots in the floor under each

of its two lanes, was then constructed to span the remaining distance across the river.

Damming of River Proves Arduous Procedure

When the actual damming of the river began, 4,500 cfs of water was flowing through the diversion channel and diversion openings in the spillway structure, and 20,000 cfs was flowing in the natural river bed. The river channel at the trestle was approximately 350 ft wide.

A fleet of 15 bottom-dump trucks of 14-cu yd capacity drove out over the upstream slots in the trestle and, in rapid succession, dumped their loads in the deepest part of the channel, turned around at the Arizona abutment, and returned over the downstream slots, to be reloaded at the Nevada quarry. This procedure was followed for about 30 hours, the rock being dumped uniformly over the entire cross section of the channel. A weir effect was created at the trestle with a head loss of approximately 5 ft at the structure, for a total flow of 17,000 cfs in the diversion channel and original river bed.

The contractor, not satisfied with the progress being made under this procedure, began loading up an entire fleet of trucks and dumping them in rapid succession between a single pair of bents, progressing simultaneously from both abutments.

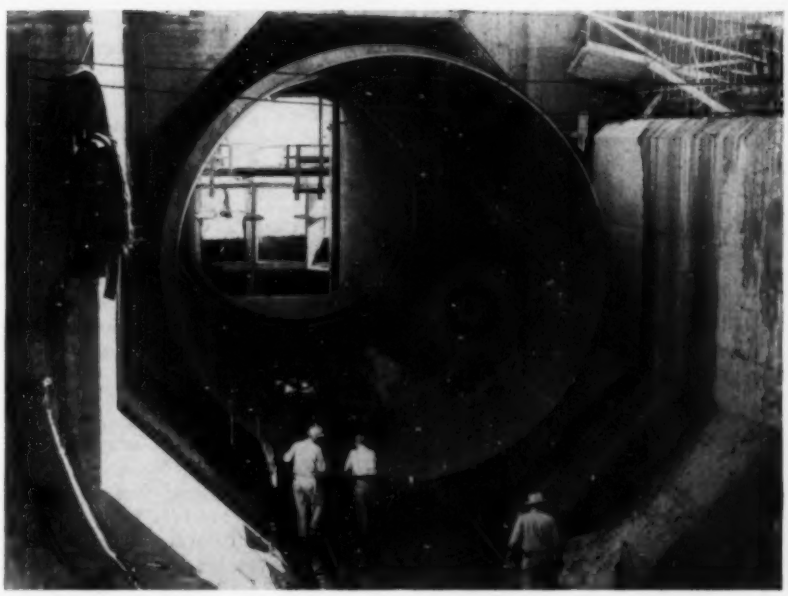
After 15 hours of this procedure the gap was narrowed down to 25 ft, and the total flow past the site was decreased to 10,400 cfs, although the loss of head at the trestle had increased to 6 ft. While the fleet of trucks was being reloaded at the quarry, the gap was widened to approximately 50 ft. Rocks as large as 1 cu yd were whisked through the openings by the swift current, and it became apparent that the gap could not be closed by merely dumping rock between the bents.

The contractor therefore began placing some structural steel sections on the upstream side of the trestle at the gap. Three large sections of interlocked steel sheetpiling were also placed there. When end-dump and bottom-dump trucks resumed operation, the steel work produced the desired effect of reducing the flow, and preventing the rock from washing away. Fifty-three hours after the first load of rock was dumped in the river, the diversion was complete. Altogether about 26,200 cu yd were dumped. The flow of the river at that time was 11,000 cfs.

The rock fill at the upstream cofferdam was built up to the level of the deck of the trestle and the decking was removed. Some semipervious material was placed on the upstream side of the cofferdam and the entire section was built up high enough to provide protection for flows up to 60,000 cfs.

Construction of the downstream cofferdam presented no difficulties. End-dump trucks dropped rock from the downstream side of a timber bridge at this location. Impervious material was dumped adjacent to it through a slot in the bridge. Semipervious material was then placed on the upstream side of the trestle.

DECOMPOSED ZONES of granite and rhyolite (left) are removed and trenches backfilled with mass concrete. Foundation conditions encountered throughout construction site necessitated numerous design changes.



STEEL PENSTOCK section is rolled into position (below) in octagonal blockout in intake structure. Concrete will be placed in blockout around penstock by pumping methods. After blockout concrete has set, joints with mass intake concrete will be pressure grouted. Unusual method was adopted when redesign of penstocks threatened to delay pouring of intake concrete.

FIFTEEN CUBIC YARDS of rock fill drop into Colorado River (left) in first attempt to fill gap in upstream cofferdam so as to divert river through diversion channel. Because of velocity of river, this method did not prove satisfactory. By loading fleet of 15 trucks and dumping them in rapid succession, contractor narrowed gap to 25 ft, but flow of river widened gap to 50 ft while trucks were reloading. Rocks as large as 1 cu yd were washed away by swift current. Steel sections and sheetpiling finally were placed along upstream side of trestle (lower left) cutting velocity of water, and gap was closed 53 hours after diversion operations began.

There was no compaction of material in either cofferdam except that provided by the traffic of placing equipment.

Construction Area Dewatered

Operations to dewater the area between the two cofferdams began immediately after completion of the cofferdam. Four pumps having a combined capacity of 15,000 gpm, operated for 7 days. On the fourth day eight additional barge-mounted pumps having a total capacity of 22,000 gpm were added. On the eighth day of pumping, nine-tenths of the surface area between the two cofferdams was dry. (See article by A. H. Ayres in CIVIL ENGINEERING for August 1948.)

Each row of well points was connected to an 8-in. header pipe. Both 8-in. and 10-in. centrifugal pumps were used to carry the water into the river upstream from the upstream cofferdam.

Because of the great width of the cutoff trench, some difficulty was encountered in keeping the entire area between the two slopes dry. To further lower the water table to permit excavating in the dry, a drainage ditch was excavated through the center of the trench and a sump pump installed near the Nevada abutment.

To dry up the center of the cutoff trench so that placement of earth fill could begin, the following plan was adopted. A perforated 16-in. pipe was placed in the drainage ditch and embedded in gravel. Two 10-in. electric pumps and two 8-in. gasoline standby pumps were placed on the Nevada abutment and connected to a header, welded into the Nevada end of the collecting pipe. This drain was grouted off when the embankment had reached an elevation where pumping from the drain was no longer necessary. A mixture of water, cement, bentonite, and sand, in ratios averaging 1:0.39:0.08:0.78, respectively, was used in the grouting. Occasionally it was necessary for some well points to be kept in operation until after they had been covered with fill. In that case, they too were grouted. Grout riser pipes previously connected to the drain and well-point headers were used to insure that the grout entered and completely filled the systems.

Dewatering of the tailrace area required two rows of well points at the upstream toe of the downstream cofferdam and one row at the toe of the upstream slope of the tailrace. The maximum rate of discharge from all unwatering systems between the two cofferdams was 61 cfs (approximately 27,000 gpm).

Four Types of Earth Fill Used

The earth fill in the dam embankment consists of four general types, referred to as Zone 1, Zone 2, Zone 3 and riprap. Zone 1 material, hauled from a borrow pit approximately 3 miles upstream from the dam, forms the impervious core of the dam and fills the cutoff trench. Zone 2 and Zone 3 materials came from required rock excavation for the appurtenant structures.

Zone 1 material was moistened to a water content of approximately 2 percent drier than the optimum for maximum compaction and compacted by 12 passes of a U.S.B.R.-designed sheepsfoot roller to a 6-in. layer. On account of the arid climate—the annual rainfall rarely exceeds 4 in.—the natural moisture content of the materials in the borrow pit was less than the required 2 percent of optimum. Irrigation was difficult because the area was highly stratified, and lenses of nearly pure silt resisted the penetration of water for many weeks. A sprinkling system of "rainmakers" failed to achieve the desired result after a period of two to three months. The plan finally adopted was to play a stream of water from a fire hose into the cut face during loading operations. Additional water was added to the embankment by sprinkling wagons if required. Several types of equipment were used to mix the materials in order to obtain a uniform moisture content. The

best of these was a tractor-drawn gang-plow that produced satisfactory results with three to four passes. A penetration resistance needle was used for field moisture and density control.

The Zone 2 sections were moistened and compacted by eight passes of the sheepsfoot roller to a 12-in. layer. Because of the high rock content of the materials, needle resistance tests were not suitable for controlling the field moisture and density of these sections. Readings at installations made for the purpose of measuring embankment consolidation indicate that satisfactory densities were obtained. Measurements in 180 ft of fill indicate that the consolidation to date has been only 0.9 ft compared to 3.0 ft in the same thickness of Zone 1 materials.

The Zone 3 materials were placed in 2-ft lifts without compaction except that provided by hauling and leveling equipment. No sluicing was done on the fill. The riprap was placed directly from end-dump trucks.

Precautions Against Reactive Expansion

Evidence of reactive expansion of concrete at Parker Dam and the experience of other organizations in this area have made concrete experts conscious of the importance of investigating the need for precautionary measures. As a direct result of laboratory tests on the reactive expansion of mortar specimens made with sand from the natural deposits used at Davis Dam, two precautionary measures were adopted. The cement used is a Type II, low alkali, modified portland cement, meeting Federal Specifications SS-C-192. It is specified that the alkalies, sodium oxide and potassium oxide, shall not be present in amounts in excess of 0.60 percent.

Pozzolan, which is a finely ground, calcined, reactive, siliceous material produced from cherty shale, is used as a partial replacement of the portland cement, 20 percent by weight, to further reduce the excessive expansion of the concrete. The portland cement plus pozzolan content of the mass concrete being placed is approximately 1 bbl per cu yd of concrete. This is increased to approximately 1.4 bbl per cu yd in the thin reinforced concrete sections.

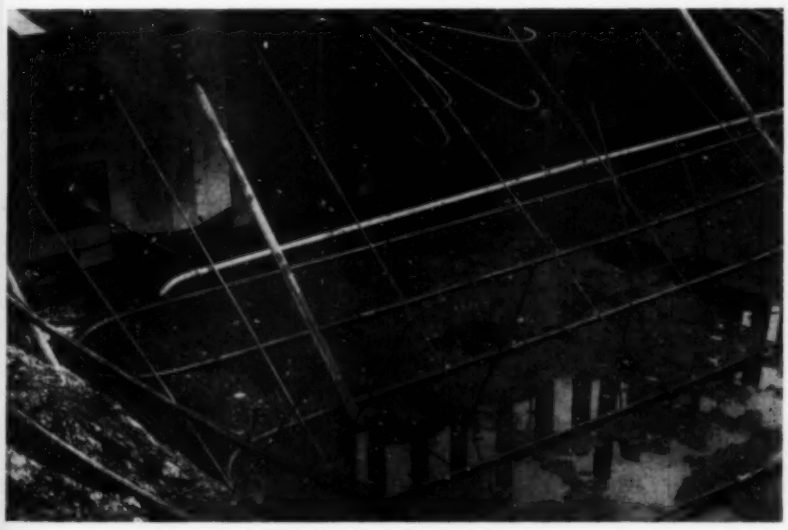
Ice Used as Part of Mix

The construction specifications require that the placing temperature of the concrete shall not exceed 80 deg F. To achieve this condition, (1) a timber shelter has been provided over the side-hill aggregate storage bins at the mixing plant; (2) a refrigerating plant cools the river water used in the mix to 40 deg F; and (3) part of the cooled water is made into ice to be batched as part of the mix water. A maximum of 100 lb of ice has been used per cu yd of concrete, the chopped ice being manufactured in tubular machines.

Two 4-cu yd mixers, the cement batchers, and the sand and coarse aggregate batchers make up the mixing plant proper. Transportation from the mixing plant to the point of placement is by an industrial double-track railroad carried on a steel trestle. Two whirley cranes, with 150 and 165-ft booms, operate on the same trestle to place all the concrete in the spillway and outlet structure, intake structure, and power plant. Small quantities of concrete for scattered locations are transported by truck. For mass placement, the contractor is using a cantilever form of the general type first successfully used at Friant Dam.

All mass concrete is cooled in place. River water, the temperature of which seldom exceeds 65 deg F, is circulated through embedded tubing placed on the rock foundation and on top of each 5-ft lift. The water is circulated until the average temperature of the surrounding concrete is within 5 deg F of the cooling water, or for a maximum of 50 days.

Work on the Davis Dam Project is under the direction of the Bureau of Reclamation, headed by Commissioner Michael W. Straus, in Washington, D.C.; L. N. McClellan, M. ASCE is Chief Engineer, with headquarters at Denver; and E. A. Moritz, M. ASCE, is Regional Director of Region 3, in which the project is located, with headquarters at Boulder City. The writer is in immediate charge of the work as Construction Engineer for the Bureau, and H. E. Williams, M.ASCE, is project manager for the contractor, The Utah Construction Co.



COOLING COILS, of 1 in. O.D., spaced about 3 ft apart, circulate river water through mass concrete until surrounding concrete is within 5 deg of cooling water, or for maximum of 50 days. Cantilever forms in background are similar to type first used successfully at Friant Dam.

CHOPPED ICE is stockpiled in anticipation of large pour of concrete on hot day. As much as 100 lb of ice per 1 cu yd of concrete was added as part of mix water at batching plant to satisfy specification limiting placement temperature of concrete to 80 deg F.

Pacific Gas & Electric Spends 3/4 Billion in Six-Year Expansion Program

H. W. HABERKORN, Assoc. M. ASCE
Engineer of Hydroelectric Construction, Pacific Gas & Electric Co., San Francisco, Calif.

HYDROELECTRIC SYSTEMS of the Pacific Gas & Electric Co. are located on 24 watersheds in California with 96 reservoirs and forebays storing over 2,000,000 acre-ft of water which is supplied each year through 382 miles of man-made waterways and 65 miles of pipelines, including penstocks, to 58 hydroelectric powerhouses with a combined installed generating capacity of 1,407,000 kva. These systems represent an investment, exclusive of transmission and substations, of approximately 300 million dollars.

These hydroelectric plants have provided substantial benefits for California by producing power at less cost than equivalent steam power and by saving the equivalent of many million barrels of oil which would otherwise have been used each year to generate the same amount of power by steam. The release of the stored water during dry periods also benefits irrigation and recreational facilities. The economic importance of these plants is further illustrated by the fact that they provide annually about $4^1/_2$ million dollars in taxes to local and state governments and an equal amount in income taxes to the Federal Government. The mountain counties of California receive a large part of their revenue from taxes on hydroelectric properties. In 1948 the P.G.&E. Co. paid property taxes to seven northern counties ranging from 57 percent of the total taxes for Alpine to 22 percent of the total for Calaveras. Developments completed since that date will further increase the share of total taxes paid by the company in the counties affected. These developments are part of a 3/4-billion-dollar postwar expansion program, which, including 20,000 miles of electric distribution lines and added natural gas facilities, calls for the expenditure of 10 to 15 million dollars per month for new construction during the six-year period 1946 to 1951 inclusive.

They have added 300,000 kva of hydro power, and by the end of 1951 will have added 1,000,000 kva of steam-electric power, a total of 1,300,000 kva to the company's system. This more than equals the total demand of the area when the war started, a demand which took half a century to develop.

Comparing the costs of this expansion program, all of it financed by private capital, to that of projects financed by public funds, the additional 3/4-billion-dollar investment of private capital is four times the cost of Hoover Dam and power plant, one and one-half times the estimated cost of the Central Valley Project when completed, two and one-half times the cost of Grand Coulee Dam and power plant exclusive of the irrigation system, and more than four times the estimated cost of the proposed San Francisco Bay crossing parallel bridge and approaches.

Construction Undertaken in 1946

When wartime restrictions were relaxed and it was again possible to proceed with construction to meet the 60 percent increased demand resulting from an increase of 40 percent in population, the most feasible developments for expansion were found to be on the Mokelumne, Yuba and Feather Rivers, which were the scene of the earliest hydroelectric developments nearly 50 years earlier.

Salt Springs Dam, originally completed in 1932, on the Mokelumne River, stores water used through the Salt Springs, Tiger, West Point and Electra Powerhouses.

In 1946 the capacity of Salt Springs Dam was increased by 9,400 acre-ft by installing a wave wall and twelve 11 × 40-ft radial gates, and construction was started on the West Point and New Electra plants between the Tiger Creek and Old Electra powerhouses.

Starting at the afterbay for Tiger Creek Powerhouse, a tunnel 13 × $15^1/_2$ ft in cross section was driven 2.75 miles to West Point Powerhouse and thence 8.2 miles farther to serve the New Electra Powerhouse.

To hasten completion, the alignment was planned to give access to the tunnel from several points. The West Point Tunnel was driven from two adits and the New Electra Tunnel from three adits and from the lower end. With the exception of two sections of very heavy ground which required many weeks to drive through, no serious problems were encountered other than those inherent in construction on a very fast schedule. Electra Tunnel was completed in 17 months, including 2.3 miles of concrete lining, or the equivalent of 100 ft of completed tunnel every day.

West Point Powerhouse, a reinforced concrete and steel frame structure 59 × 75 ft, rising 90 ft above the foundation, houses a 16,000-kva, 300-rpm, reaction-turbine-driven generator. Water from the tunnel is delivered to the turbine under a static head of 312 ft through 623 ft of steel pipe from 10 to 7 ft in diameter. To permit bypassing of the West Point plant, a concrete gravity diversion dam 26 ft above stream bed was constructed and an 8-ft-dia pipe bypass was provided to carry the water from the river directly to the Electra Tunnel after it has passed through the West Point Plant.

The 8.2-mile Electra Tunnel empties into Lake Tabeaud, a small regulating reservoir or forebay, from which the water is conveyed through 2,900 ft of 12-ft-dia concrete-lined tunnel and 3,251 ft of 10- to 6-ft-dia steel pipe to the New Electra Powerhouse under a static head of 1,268 ft.

The New Electra Powerhouse is a reinforced concrete and steel frame structure 230 × 88 ft, rising 68 ft above its foundation. It houses three 33,000-kva, 225-rpm, horizontal-shaft generators, each driven by twin impulse wheels.

A short distance downstream from the old powerhouse, a concrete gravity check dam 320 ft long by 22 ft high was constructed across the river. A number of slots through the dam control the flow of water to users further downstream, including the East Bay Municipal Utility District.

The New Electra Powerhouse was put in operation in July of 1948 and the West Point in December 1948.

The watershed of the Bear River, a tributary of the Mokelumne, remains to be developed. A rockfill dam creating a lake of 50,000 acre-ft of storage will be constructed a short distance below the existing Bear River Dam. Water stored behind both these dams will be conveyed through a 2.6-mile tunnel to the head of a 4,900-ft penstock 5 to 4 ft in diameter. Water will be delivered under a static head of 2,104 ft to an impulse-wheel-driven generator of 33,000-kva capacity to be installed in the existing Salt Springs Powerhouse building. Work on this development is scheduled to start this fall, with completion in the spring of 1953.

The third plant to be put in operation during the present expansion program was New Colgate, on the site

of the original plant constructed in 1899. This is on the Yuba River, a tributary of the Feather. It was originally served by a wood flume 7 miles long. In 1941, the flume was replaced with a $4^2/_3$-mile tunnel 10 × 11 ft in cross section. In November 1948, the old plant was dismantled. The five 30-in.-dia steel and cast-iron penstocks were replaced by a single 1,630-ft steel pipe 8 to $5^1/_2$ ft in diameter. By operating the tunnel as a pressure conduit, 100 ft of head was added, making the total static head 820 ft.

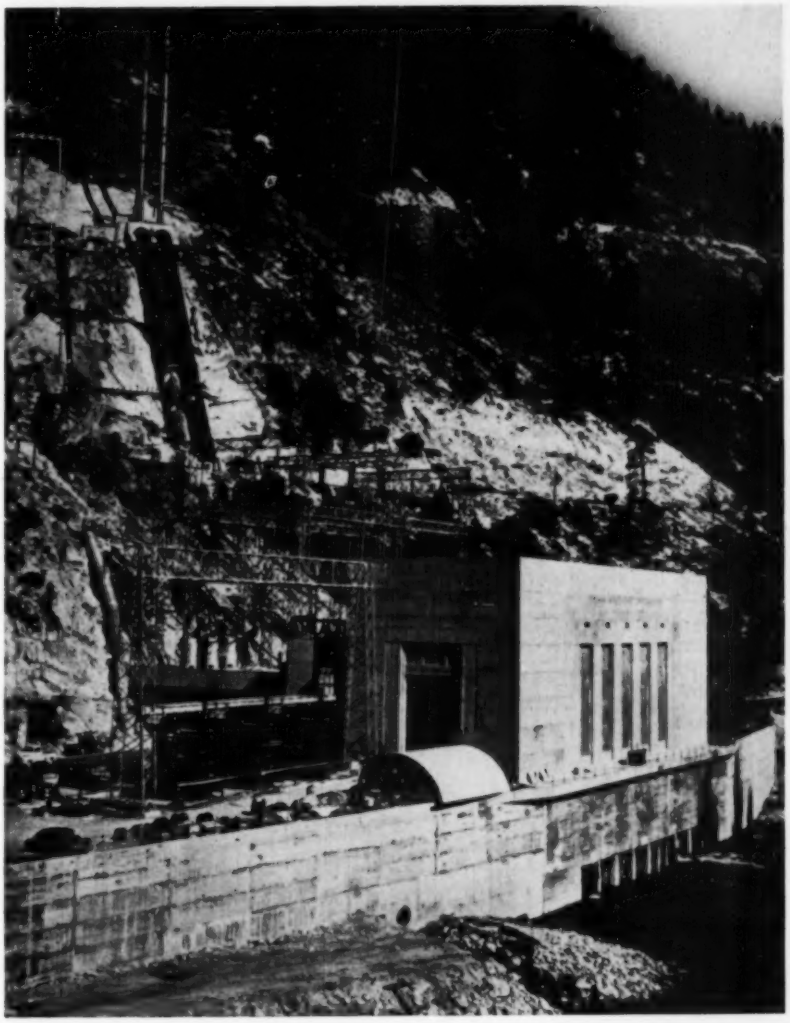
The powerhouse, a reinforced concrete structure 70 × 77 ft extending 49 ft above the foundation to the generator floor and 50 ft above that to the roof, houses a single, vertical-shaft, reaction-turbine-driven generator of 30,000 kva, or double the capacity of the old plant. The new powerhouse was put in operation in June 1949, just eight months after the old plant was shut down.

The final stage of this expansion program occurred on Feather River where two new developments, Rock Creek and Cresta, have just been completed, between the Caribou and Big Bend plants, commissioned respectively in 1921 and 1908. Their combined capacity of 201,000 kva is slightly greater than the total of the three existing plants on the river. Suitable sites exist for 300,000 kva of additional capacity, which will be developed at some future time.

Cresta Development Completed

Cresta diversion dam, 35 miles above Oroville, was completed last November on the Feather River. It is 384 ft long at the crest and contains 80,000 cu yd of concrete. To unwater the foundation, the river was diverted by means of a levee through a short tunnel driven around the left abutment. Bedrock was uncovered 37 ft below the river bed and the dam rises 152 ft above it. A conveyor belt carried aggregate to a batching plant at the left abutment on the downstream end of the dam and the 80,000 cu yd of concrete were placed by two derricks.

After the dam was complete, the installation of two drum gates began. Like those at Rock Creek, they are wedge-shaped, 124 ft long and 28 ft high, hinged along one edge and floating in a chamber constructed for each at the crest of the dam. The gates are controlled automatically by floats so as to hold the water in the lake at a maximum level regardless of flow. The lake level is particularly important at Cresta since the static head is only 290 ft.



ROCK CREEK POWERHOUSE on Feather River, California, delivers 126,000 kva to Pacific Gas and Electric Company's power system. Recently completed plant is one of five constructed under company's $^3/_4$-billion-dollar postwar expansion program.

A reinforced concrete intake protected with a steel trash rake admits a maximum of 3,500 cfs into the 4-mile Cresta tunnel. This tunnel is horseshoe-shaped in section, 27 × 27 and 26 × 26 ft, and located in good granite only 2,000 ft of which required concrete lining. The upper section of the tunnel, which was used temporarily for diversion, was driven from a separate adit. The remainder was driven from an adit at Bear Creek, from the lower portal, and in each direction from Grizzly Creek, at which point the tunnel comes out into the open. Here the canyon is spanned by a circular reinforced concrete tube 19 ft in diameter, supported on a concrete arch.

To facilitate driving operations at all headings of Cresta as well as in Rock Creek tunnel, drill jumbos, on which 12 to 15 pneumatic rock drills are mounted, were employed. While the broken rock is being loaded into cars by mucking machines, a hoist or "cherry-picker" installed at the rear end of the jumbo, is shifting cars, the empty cars being hoisted out of the way to permit the loaded car to be hauled back. The empty car is then lowered back to the rail and pushed to the heading to receive its load. In the central section of Cresta Tunnel, and for most of Rock Creek Tunnel, twin mucking machines were used, working side by side on separate tracks, so that each loading operation could proceed independently of the other.

A surge chamber was constructed in an adjacent canyon and 970 ft back from the outlet portal. The chamber is 46 ft in diameter and 123 ft high

with a 16-ft-dia riser in the center. It is lined entirely with concrete and, like Rock Creek surge chamber, is of the differential, non-overflow type.

The lower end of Cresta Tunnel is in a disintegrated granite formation requiring the use of a steel liner in the lower 602 ft. Twin penstock pipes 12 ft in diameter, each 759 ft long, carry the water to the powerhouse turbines, passing under the state highway in a reinforced concrete culvert constructed for that purpose.

The Cresta Powerhouse building required extensive excavation to reach suitable rock. It is a 70-ft-high reinforced concrete substructure surmounted by steel-frame and concrete curtain-wall structure 176 × 98 ft, rising 62 ft to the roof.

Equipment consisting of two 37,500-kva vertical-shaft generators direct-connected to the 46,500-hp reaction turbines revolving at 180 rpm, is handled by two 110-ton-capacity cranes. A three-unit transformer bank steps up the generator voltage of 11,500 v for transmission at 220,000 v. Cresta Powerhouse was put in operation in November 1949 and January 1950.

Rock Creek Development

Approximately 3 miles above Cresta Diversion Dam another concrete gravity dam was constructed, similar in all respects to Cresta Dam except that it is 562 ft long at the crest and contains 153,000 cu yd of concrete. The river was first diverted in the summer of 1948, after which it was necessary to excavate 65 ft of gravel to reach bedrock. Starting in September 1948, concrete was placed in approximately 60 × 40-ft blocks 8 ft thick, using a cableway with a movable head tower and a 4-cu yd bucket. The cableway, together with the batching plant and bulk cement silo, formed a modern concreting plant capable of placing over 2,000 cu yd per 24 hours. The dam rises 160 ft above its foundations. At its crest there are two openings in which drum gates exactly like those at Cresta Dam will be installed this year as soon as danger from high water has passed.

Rock Creek Dam diverts 3,000 cfs into a 6.5-mile 25 × 25-ft horseshoe-shaped tunnel. Some world records for driving a tunnel of this size were made in both the upper and lower ends, where advances of 44 and 47 ft in 24 hours have been achieved. Many weeks the advance was in excess of 200 ft in six days.

Because of the blocky formation, it was necessary to support 21,000 ft with timber during driving and later to line these sections with concrete. The lining was placed pneumatically behind collapsible steel forms in a continuous operation 24 hours per day. A total of 175,000 cu yd was required for the lining, or more than was placed in the diversion dam. In the central section, 150,000 cu yd were placed in a five-month period.

On account of the soft and disintegrated nature of the formation, the surge chamber was constructed entirely underground in sound granite about 900 ft from the lower end of the tunnel. The chamber is from 55 to 46 ft in diameter, 131 ft high and Gunite lined except for the 12-ft-dia riser in the center, which is of reinforced concrete. The nature of the formation made it desirable as an added safety measure to place a steel liner inside the concrete lining on the lower 384 ft of tunnel.

Rock Creek Powerhouse was constructed on the steep bank of Feather River at a location where both the Western Pacific Railroad and the state highway are on the same side of the river. It was necessary to shift the highway location somewhat and to construct a heavy reinforced concrete structure over the highway to support the switch structure and the 400 tons of oil switches.

The powerhouse site was unwatered using a semicircular levee which has also served as a temporary detour for the highway. Foundations extend 14 ft below river bed to bedrock. The powerhouse, like Cresta Powerhouse, is a composite reinforced concrete and steel-frame building 176 × 87 ft, which rises 61 ft above the foundation to the main floor and thence 66 ft to the roof. Two cranes of 135-ton capacity handle equipment during installation and will serve for maintenance in future years.

The tunnel is connected with the powerhouse by two 12-ft-dia steel penstock pipes, which taper to 10½ ft at the turbines. Each pipe is 930 ft long and connects to the spiral casing of a 73,500-hp vertical-shaft reaction turbine. Both turbines are direct-connected to a 63,000-kva, 240-rpm generator. A three-unit transformer bank installed in the yard at each end of the powerhouse steps up the 13,800-v generator voltage for transmission at 220,000 v.

The existing Feather River plants are served by two steel tower lines. To handle the additional power, a third line was constructed from Rock Creek Powerhouse to Oroville. The presence of the two operating transmission lines, the Western Pacific Railroad, and the state highway beneath it presented many construction problems. To reach the tower sites for construction of the concrete footings and erection of the towers, it was necessary to install tramways or other means of access.

To solve this problem economically, a scheme was borrowed from the lumber industry. Torpedo-like tubes of 16-in. diameter and 21-ft length, closed at each end and connected to

(*Continued on page 87*)

Load Capacity of Southern California Edison Company Expanded to 2¾ Billion Kwhr per Year

W. L. CHADWICK, M. ASCE

Manager, Department of Engineering, Southern California Edison Co., Los Angeles, Calif.

WHEN the current project—Big Creek No. 4—of the Southern California Edison Co. is completed, the company will have a total of more than a half million kilowatts of developed power on the San Joaquin–Big Creek system, capable in an average water year of generating more than 2¾ billion kwhr. The average cost, including transmission lines, will be about $258 per kw.

The Big Creek No. 4 project is but a part of the Company's plant expansion since the war, which has included the addition of 370,000 kw of new capacity. No additions were made to the Big Creek–San Joaquin development from 1929 to 1948 because of adverse economic, competitive, and war conditions, but in 1948 a fourth unit and 37,000 kw were added to Powerhouse No. 3. This addition brought the total power developed on the Big Creek–San Joaquin system to about 435,000 kw, but left one drop of 420 ft to be developed between the tailrace of Big Creek Project No. 3 and the Kerchkoff Reservoir

serving the Kerchkoff Plant of the Pacific Gas & Electric Co. This drop is being developed by the Big Creek No. 4 project now under construction.

Variety of Structures Included in Project

The Big Creek No. 4 project includes a concrete gravity dam 250 ft high across the San Joaquin River about 6 miles below Big Creek No. 3 Powerhouse. The dam impounds a 35,000-acre-ft reservoir extending to the tailrace of the No. 3 plant. Also included in the project are two sections of 24-ft-dia tunnel totaling 2 miles in length, a short connecting steel conduit of $15\frac{1}{2}$-ft diameter, a single 15-ft diameter all-welded steel penstock, a powerhouse containing two 42,000-kw turbine generators, and an additional 230-kv transmission circuit to the Los Angeles area, 258 miles long.

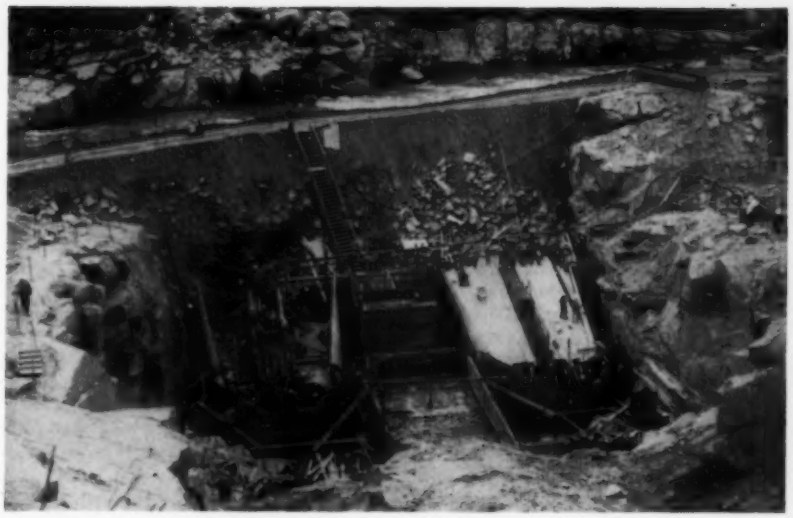
The first work at the dam was authorized late in May 1949. Dam excavation proceeded throughout the summer. The river was diverted around the dam site on October 1, and construction, plant erection, and excavation were sufficiently advanced by November 17 to permit placing the first concrete. Concrete has now reached a height of 135 ft above the lowest foundation and more than 53 percent of the concrete required for the dam has been placed. As there are no natural aggregate deposits of any size in the area, aggregates are being made from granite tunnel muck and quarried rock. Six sizes with a maximum of 6-in. rock are being used. Concrete is placed by means of a 4-cu yd cableway bucket with traveling head tower.

Tunneling started late in September 1949. The first section, 2,535 ft long, was driven principally from one end and was completed in 80 working days. Work started on the second section in early January 1950. A total of 3,119 ft has been driven to date at an average of 36 ft per day, a record for a 24-ft tunnel in hard granite.

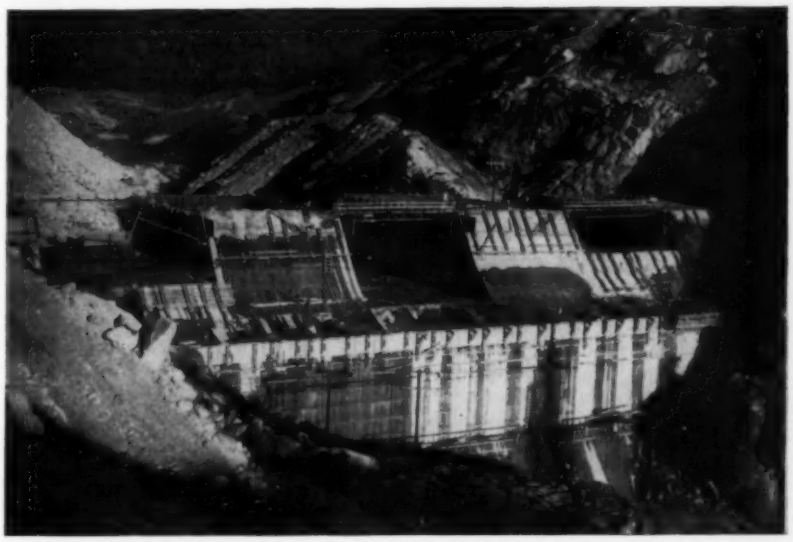
Drilling Jumbo Carries 13 Drills

Drilling is from a highly refined rail-mounted jumbo, carrying 13 IR 35 automatic feed and retraction drills, using carset bits. The three top drills are mounted on extensible arms actuated by hydraulic jacks and can be pointed almost parallel to the roof; as a result overbeak has been at a minimum. The pipe frame of the jumbo forms the air receiver. About 96 holes are drilled per round and an average of about $3\frac{1}{2}$ lb of 45-percent dynamite is needed per cu yd.

Mucking is by two-motored Conway machines. Haulage is by battery-operated locomotives and 6-cu yd mine-type dump cars.



FORMS FOR DRAFT TUBES and powerhouse substructure are placed inside cofferdam at site of Big Creek No. 4 hydro project of Southern California Edison Co. San Joaquin River can be seen flowing between cofferdam and rock ledge in background.



LOW CENTER BLOCK of spillway permits passage of possible flash floods in San Joaquin River during construction of Big Creek No. 4 Dam of Southern California Edison Co.

Powerhouse excavation has been completed and substructure concrete is being placed. Penstock excavation has been completed as has also excavation for the switchyard. Transmission-line towers founded on bell-bottom pile footings have been erected over 80 miles of the route and stringing is complete over 47 miles. Completion of the entire project is expected by July 1951. The cost for 84,000 kw of nameplate capacity is expected to be about $21,000,000.

The new project is being designed and constructed for the Southern California Edison Company by Bechtel-Morrison Knudsen. It will have been built without public funds and in spite of tax loads amounting to as much as $25.86 per kw year in a year like 1945 and $14.48 in 1949.

Since the war the Company's gross expenditure for new plant has been $214,500,000. There has been no increase in the price of power on the system served by the Big Creek–San Joaquin project since 1922—rather there has been a continuous decrease. California's hydro potential has been well utilized by such projects, serving both irrigation and power.

Big Machines Speed Delta-Mendota Canal Construction

O. G. BODEN

Construction Engineer, Bureau of Reclamation, Tracy, Calif.

IN CENTRAL CALIFORNIA the Sacramento Valley has about two-thirds of the available water and the San Joaquin Valley about two-thirds of the irrigable land. To more nearly balance this inequality, the more than $400 million Central Valley Project was conceived and is now under construction. In fact, parts of it are in operation. As shown in Fig. 1, the project extends from Shasta Dam on the Sacramento River north of Redding, some 500 miles southward to the proposed terminus of the Friant-Kern Canal near Bakersfield.

Before San Joaquin River water, impounded in Millerton Lake by Friant Dam near Fresno, could be diverted 37 miles to the north by the Madera Canal and about 150 miles to the south by the Friant-Kern Canal, it was necessary to develop substitute water for the San Joaquin water users downstream from Friant Dam. The most economical source of such a supply is Sacramento River water partially impounded by Shasta Dam during periods of high runoff and subsequently released through natural waterways. At a point about 30 miles downstream from Sacramento, the Delta Cross Channel is to be constructed to divert water from the Sacramento River to a point near the bifurcation of the north and south forks of the Mokelumne River, and then release it into natural channels. From that point to the intake of the Delta-Mendota Canal, located about nine miles northwest of Tracy, the flow of Sacramento River water across the delta will be by a combination of gravity and the drawdown at the Tracy Pumping Plant.

The Delta-Mendota Canal is one of the key features of the project, and its primary purpose is to conduct water from the Delta 116½ miles southeasterly and to discharge it into the San Joaquin River, about 30 miles west of Fresno at Mendota Pool. The canal water thus provides a replacement for the San Joaquin River water stored by Friant Dam. In addition, the canal will supply limited amounts of water for irrigation of new land and supplement the supply of existing irrigation districts.

One of West's Largest Man-Made Rivers

The Delta-Mendota Canal, construction of which began in 1946, is one of the largest man-made rivers in the West. It has an initial capacity of 4,600 cfs and progressively decreases in size throughout its length, discharging into the Mendota Pool with a capacity of 3,200 cfs. The 2½-mile section from Old River, one of the principal Delta channels, to the Tracy Pumping Plant, is of unlined construction, with a bottom width of 66 ft and 3:1 slopes for the water prism. At the Tracy Pumping Plant, six 767-cfs pumps lift the water about 200 ft vertically and discharge it through three concrete lines each 15 ft in inside diameter and about 5,000 ft long. Each pump is driven by a 22,500-hp motor.

FIG. 1. EXCESS FLOW from Sacramento River stored behind Shasta Dam, in northern part of California's Central Valley, irrigates thirsty land along San Joaquin River, in southern part of Valley. Water flows down Sacramento River to Delta Cross Channel and into lower San Joaquin River; here Tracy Pumping Plant lifts 4,600 cfs height of 200 ft into Delta-Mendota Canal. This man-made river, which will flow southward for 116 miles, in opposite direction to San Joaquin River, is expected to be completed by mid 1951.

From the end of the discharge pipes, the Delta-Mendota Canal follows a grade contour along the fringe of the foothills on the west side of the San Joaquin Valley for about 113 miles. The first 95 miles will be lined with 4 in. of concrete and will have a constant bottom width of 48 ft, side slopes of 1½:1, and a vertical lining height varying from 17.87 to 15.54 ft. The last 18 miles will have a bottom width varying from 60 to 84 ft and 2½:1 side slopes, with compacted earth lining on the base and inside slopes.

Construction of this magnitude taxed the ingenuity of the contractors—Morrison-Knudsen Co., Inc., M. H. Hasler Construction Co., the Western Contracting Corp., and others—and resulted in the development of some massive mechanical construction equipment. One of the major tasks is

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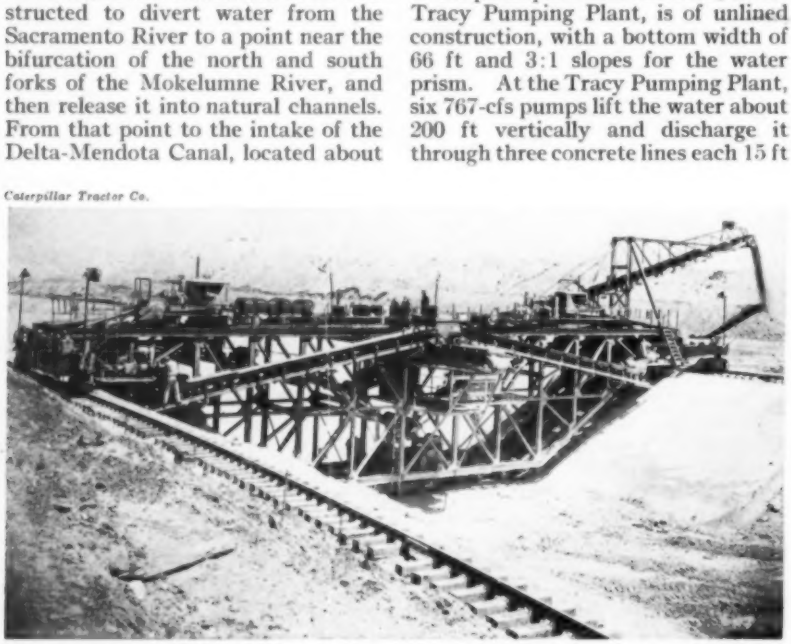
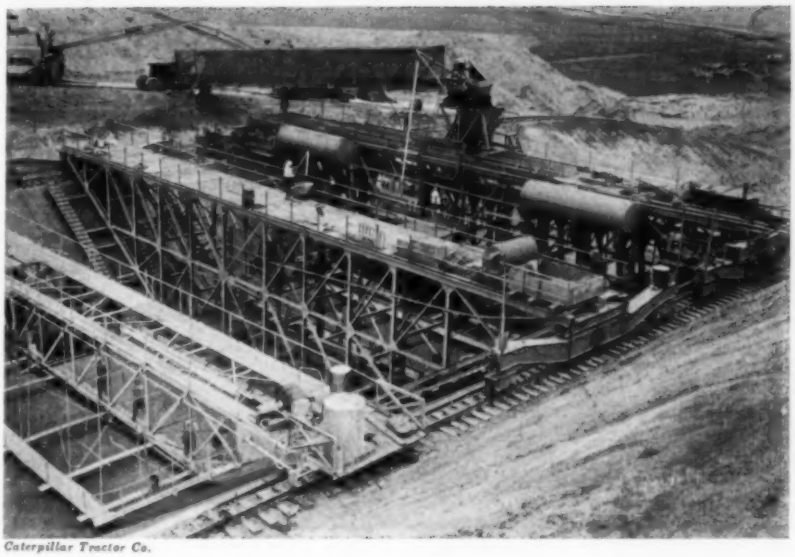


EXCAVATING 45 million cu yd in Delta Mendota Canal is machine job. Contractors Morrison-Knudsen Co. and M. H. Hasler Construction Co. use large draglines to take out main prism; carryalls and rollers to build up and compact banks; and bulldozers, motor graders, and small draglines to finish excavation. Before concrete lining is placed, 170-ton rail-mounted electrically operated trimming machine, here shown, finishes bottom and side slopes to exact grade.



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BEHIND TRIMMER, rail-mounted slipform machine (leading at right, above) vibrates and screeds 4-in. plain concrete lining into place. Behind slipform follow finishing jumbo (middle, above) and curing jumbo (at left, above). From latter, white curing compound is sprayed on. Another type of slipform is seen at left. Diesel-electric generators, mounted on all these machines, supply power for their multi-motored operation. Best lining progress to date is 20,000 lin ft in 20 working days.

the excavation which, for the canal and four appurtenant wasteways, is estimated in excess of 45,000,000 cu yd. Excavation of this magnitude requires the use of large equipment, the largest being a walking dragline having a 15-cu yd bucket which has excavated 20,000 cy yd in a three-shift day. At locations where the top of the concrete canal lining is above the natural ground surface, a compacted core bank is constructed with a minimum top width of 10 ft adjacent to the lining.

In the sequence of construction operations, the compacted banks are constructed in advance of the dragline excavation by use of carryalls or similar mechanized earth-moving equipment, and compaction to 95-percent laboratory density is obtained by large rollers. These compacted banks will exceed $3\frac{1}{2}$ million cu yd for the entire canal. Following compaction, the draglines excavate the remainder of the canal prism and cast the material on one or both sides. In large thorough cuts, a portion of the excavation is sometimes moved by carryalls. For use in the concrete lining operations and for operational safety and convenience, a 5-ft berm is left at the top of the lining on both sides of the canal.

After the canal prism has been roughly excavated, the contractors bring the prism as near as possible to the specified grade and section by the use of bulldozers, motor graders, and small draglines.

Heavy railroad rails, laid to line and grade on the berms on both sides of the canal, support, in succession, the trimming machine weighing about 235 tons, the slipform or lining machine weighing about 200 tons, and the finishing and curing jumbos. Trimming machines in use are constructed on different excavating principles. One contractor's machine uses bucket-line excavators and the other, oscillating-type cutters similar to those on certain highway graders.

Following trimming operations, the slipform machine, traveling on the same rails, places the 4-in. unreinforced concrete lining. The lining machine is basically a traveling screed and forming templet with high-frequency-tube vibrators positioned ahead of the screed in the concrete hopper. The vibrators, located slightly below the finished surface of the concrete and extending completely across the bottom and up to the top of both side slopes, serve the dual purpose of converting the concrete in the hoppers into a workable condition that will permit it to flow into the form at the screed, and simultaneously compacting it into a substantially solid lining. The screed and forming templet strike off the material to grade and apply a relatively smooth finish.

Trucks operating on the canal banks haul dry-batched material from the aggregate plant to the scene of the lining operations, where the concrete is mixed in two No. 34E double-drum pavers. After the concrete is discharged from the mixers, two manually controlled transfer cars deliver it to circular chutes which are connected to the hopper ahead of the screed. Manual control of the transfer cars

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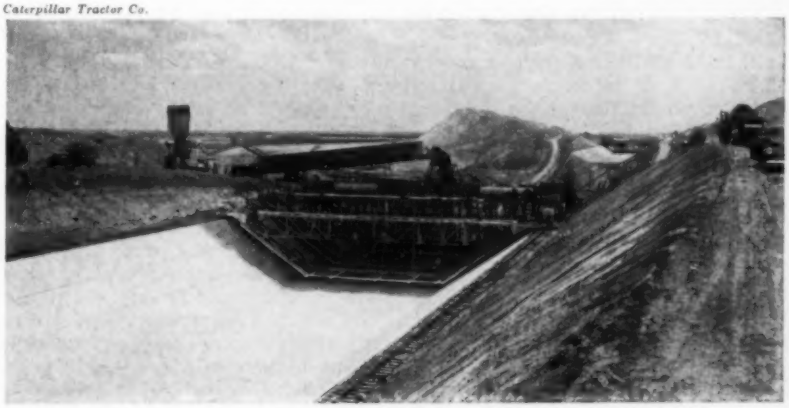

WHERE CANAL CROSSES water courses, highways, railroads and pipelines, heavy trimming and lining machines either pass obstacles under their own power or, where service cannot be interrupted, are hauled out bodily on flat-bed trailers on canal bank and reinserted on other side. In view right, trimmer is seen in canal prism at far right after passing location of Mountain House Siphon. Slipform and finishing and curing jumbos have completed lining up to siphon site and are ready to cross depression under their own power.

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MOUNTAIN HOUSE SIPHON, single-barreled structure of 24-ft inside diameter, 1,000 ft long, with 24-in. 3-in. walls, is seen ready for backfill. Siphon carries Delta-Mendota Canal under a creek and a paved highway.

permits uniform distribution of concrete to the lining.

One of the most important factors in the production of satisfactory concrete lining is the manufacture and control of workable concrete. At present, the lining concrete has the following components: 38 percent sand; 8 percent No. 4 to $^3/_8$-in. aggregate; 25 percent $^3/_8$- to $^3/_4$-in. aggregate; 29 percent $^3/_4$- to $1^1/_2$-in. aggregate; 1.30 bbl of cement; and 3 percent average entrained air at the mixer. The concrete, which is placed with approximately a 2-in. slump, develops a 7-day strength averaging 2,000 psi and 3,300 psi at 28 days.

The present finish requires a relatively small amount of hand troweling in roughened areas and adjacent to the grooves. Specifications provide that:

> "The finished surface of the lining shall be equivalent to that obtained by effective use of a long-handled steel trowel. Light surface pitting and light trowel marks will not be considered objectionable. When the surface produced by the lining machine meets the requirements, no further finishing operations will be required."

Transverse grooves are cut in the lining by hand at about 12-ft intervals, and longitudinal grooves are cut at about 11-ft intervals by cutters mounted on the rear of the slipform. The grooves concentrate the cracking which occurs during curing and as a result of climatic temperature changes. The grooves are $1^1/_4$ in. deep and $^1/_2$ in. wide on top, and on some of the contracts are being filled with an internal setting mastic. On recent contracts, the mastic has been omitted but possibly will be placed prior to operation of the canal. When the grooves have been cut, the entire lining surface is sprayed with white pigmented curing compound.

Peculiarly enough, the limiting factor in the production of concrete has been mixer capacity. To date, the record for an $8^1/_2$-hour day has been 1,695 cu yd of concrete placed in 1,185 lin ft of lining. In the best month to date about 20,000 lin ft of lining was placed in 20 working days. Total concrete in the lining of the Delta-Mendota Canal and the smaller Westley and Newman Wasteways is estimated at 687,500 cu yd.

A major problem in connection with trimming and lining the canal is the movement of the equipment over and around obstructions, such as railroads, oil and gas pipelines, and some other major structures. The normal procedure at such structure sites is to construct temporary embankments parallel to the canal centerline at berm location, thus permitting the laying of rails and the movement of the machines under their own power. Railroad and large high-pressure oil or gas lines, on which service cannot be interrupted, are crossed by ramps excavated normal to the canal, over which the slipform and trimmer are hauled intact from the canal on large low-bed trailers, and then reintroduced into the canal on the other side of the obstruction by the same method.

As the Delta-Mendota Canal traverses the edge of the foothills, it crosses numerous drainage courses, highways, and other obstacles which make some large structures necessary. The largest single-barrel siphon is the Mountain House Siphon near Tracy, which passes under a paved highway and creek, and has a length of 1,010 ft from headwall to headwall, an inside circular diameter of 24 ft 3 in., and a 24-in. wall thickness. This structure alone contains 8,460 cu yd of concrete and 1,200 tons of reinforcing steel.

Where the hydrostatic head is low, multiple box-type siphons are used. A typical example is the Orestimba Creek Siphon near Newman, which consists of four 12-ft-wide by 16-ft-high barrels 330 ft long. The structure contains 3,400 cu yd of concrete and over 250 tons of reinforcing steel. By the time the canal is completed, an estimated 12,000 tons of reinforcing steel will have been placed in the more than 120,000 cu yds of concrete in structures.

Placement of this quantity of structural concrete inspired the contractors to develop some ingenious adaptations for their mixers. One contractor removed the boom and replaced it with a conveyor belt discharging into a circular drop chute. The belt is articulated at the mixer so that it can be moved both vertically and horizontally, thus permitting the mixer to remain outside the excavation while depositing the concrete directly into the structure forms without the use of falsework or buggies.

Tracy Pumping Plant, "Heartbeat" of Project

One of the major features of the canal is the Tracy Pumping Plant which has been referred to by the press as the "heartbeat of the Central Valley Project." This plant is about 9 miles northwest of Tracy, at the downstream end of the $2^1/_2$-mile-long unlined inlet canal in a cut about 70 ft deep.

The plant building is of reinforced concrete 60 × 362 ft in plan and about 82 ft high from foundation to roof slab. To protect the plant against earthquake and pump-thrust loads, the building was erected on 2,953 timber piles 40 ft long. Foundation conditions encountered were such that holes for the piles were bored prior to driving.

The pumping plant will contain six 84-in., 767-cfs vertical-shaft centrifugal pumps each powered by a 22,500-hp motor. A 100-ton gantry crane on the roof serves the multiple purpose of handling the motor parts direct through circular roof hatches, handling bulkhead gates on the front of the plant, and moving the 21-ton pump gallery crane. This crane, which incorporates features for delivering 40 tons of jacking pressure, will

IN TRACY PUMPING PLANT, six 84-in. motor-driven pumps lift 4,600 cfs 200 ft into Delta-Mendota Canal. Structure rests on 2,953 wooden piles 40 ft long. Power for six 22,500-hp motors will be generated at Shasta Dam. One-hundred-ton gantry crane will install and maintain motors, handle bulkhead gates, and move single 21-ton pump-gallery crane from bay to bay.

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be used for servicing and repair of non-embedded parts of the pumps. A unique feature is that the one gallery crane will be used by all six units and will be lifted from bay to bay by the 100-ton gantry crane.

Discharge Lines of 15-Ft Diameter

Three discharge pipelines of 15-ft inside diameter, about 4,875 ft long, will convey the water from the pumps to the canal. The upper 1,900-ft of the discharge lines, built to withstand heads from a maximum of 120 ft to almost none at the point of discharge into the canal, is of monolithic construction, heavily reinforced and having a wall thickness of 15 to 18 in., depending on the head.

The high-head parts of the discharge lines are constructed of what is reported to be the largest precast concrete pipe ever manufactured. This pipe, which has a 15-in. shell thickness and was manufactured in 12-ft laying lengths, is designed to withstand varying heads from 120 to 220 ft. A hydrostatically tested steel cylinder, varying in thickness from $^1/_4$ to $^5/_{16}$ in., is embedded in the concrete 2 in. from the inside face. Prestressed steel bell-and-spigot rings are attached to the ends of the cylinder. An outer reinforcement of $^7/_8$- to $1^1/_2$-in. bars, located near the outside of the pipe, is used in all cases, and in pipe designed for a head of over 150 ft, the outside of the steel cylinder is spirally wound with smooth reinforcement steel. A total of 731 joints of this pipe were manufactured.

Cages and cylinders were manufactured in the United Concrete Pipe Corp. plant at Stockton and were trucked to a special pipe casting plant erected adjacent to the Tracy Pumping Plant, where the actual manufacture was performed. Eighteen steel base rings mounted on heavy concrete slabs were used to hold the inside and outside steel forms. In manufacture, the inside form was clamped in position, the cylinder and reinforcement cage placed in position as a unit, and the outside form then placed and clamped.

A spider spreader was placed on top of the form to maintain the alignment and provide rigidity for the upper part of the form. A metal cone was placed on the spider to provide uniform distribution of concrete to the forms. Railroad cranes, operating on tracks parallel to the base ring foundations, handled the forms, cylinders and concrete. While the concrete was being placed in the pipe forms, eight external vibrators mounted on the outside form were operating at 9,500 vibrations per min. Each pipe section contains approximately 27 cu yd of concrete.

Reuse of Forms Is Necessary

Since eight sections of pipe were manufactured each day, and there were only six sets of forms, two sets of forms had to be reused each day. Four to six hours after placement of concrete in the first two pipes manufactured each day, the forms that were to be reused were stripped and a large wooden box placed around each pipe while it was still on its base ring. Thoroughly saturated steam was then introduced into the box to produce a curing temperature of from 120 to 150 deg F. Curing continued for a minimum of 36 hours. On the other six pipes, from which the forms were not removed, the steam boxes were placed an hour after completion of concrete placement and the steam applied until the forms were removed. Steam curing was then reapplied and continued for 30 to 36 hours. At the end of the curing period, the pipes were removed from the base rings and transported to the storage yard, stored on end, and allowed to cool to air temperatures. When cool, they were thoroughly saturated with water to replace the moisture lost after manufacture and painted with white pigmented curing compound.

Hauling and transportation of pipe, each joint of which weighs from 60 to 62 tons and had to be moved considerable distances from the pipe plant to the storage yard and then to the trench, presented a problem which taxed the ingenuity of the contractor. A large double A-frame mounted on pneumatic tires and drawn by a track-laying tractor, was used to handle the pipe. The device was backed over the pipe as it sat on the base rings, and a large cable-supported steel band was lowered around the pipe and contracted by hydraulic cylinders. When the band was firmly clamped, the pipe was lifted from the base ring by a hydraulic hoist. The device transported the pipe in a vertical position suspended on the hoist cables. During laying operations, the pipe was transported from the storage yard to the trench site in a vertical position and then turned to a horizontal position by a cable hoist and placed on blocking adjacent to the trench.

The pipe was laid in the trench on a previously prepared sand bed by a large crawler-type crane. Joints are made watertight by calking between the bell-and-spigot rings with a compressible lead gasket $1^3/_4$ in. wide, having a $^5/_{16}$-in. maximum thickness. The space between the ends of adjoining pipe is filled on the inside with pneumatically placed mortar and on the outside with cement grout. Before the earth backfill is placed, lean concrete backfill 2.5 ft thick is poured against the pipe in the bottom of the trench.

The Bureau of Reclamation is justly proud of the construction being performed and appreciative of the efforts of the contractors who are performing it. Construction of this man-made river, which was begun in 1946, is scheduled for completion by mid-summer of 1951, and this schedule will be maintained.

Man-Made Rivers of Rival Natural

A. J. DAVIDSON, Assoc. M. ASCE

Chief, Office Engineering Subdivision, U.S. Bureau of Reclamation, Ephrata, Wash.

WORKMEN ERECT STEEL for inlet transition section of Bacon Siphon, designed to operate at head of 95 ft. Constructed of reinforced concrete, siphon is 23 ft 3 in. in inside diameter. Wrought-iron seal ring used between sections is visible on face of shell. Bacon Siphon is one of 46 inverted siphons in the Columbia Basin Project.

IN A LAND of mammoth engineering projects, the Columbia Basin Project stands as a giant among giants. It includes the world's largest concrete dam, the world's largest power plant, and the world's largest pumping plant. Its gravity canals, irrigating a million acres of land, are indeed man-made rivers. Not only is the project extraordinary in size, but its construction is difficult, since much of the excavation is in rock. For example, $1^1/_4$ million cu yd of solid basalt were excavated from the first $1^1/_2$ miles of the Main Canal. The project, Fig. 1, extends from Coulee Dam on the north 160 miles (by road) south to Pasco, and from the Columbia River on the west some 50 to 60 miles east into the dry-land wheat area.

The general scheme for getting water from the Columbia River to the land was to build Grand Coulee Dam, which raises the river level and thus reduces the pumping lift. Power generated at the dam will be used to pump the water up an average of 280 ft into Grand Coulee. Thence it will flow by gravity canals to the lands of the Columbia Basin.

The principal features of the project, besides Grand Coulee Dam, are:

1. **Grand Coulee Pumping Plant,** which will lift water an average of 280 ft, utilizing twelve 1,600-cfs pumps, each powered by a 65,000-hp motor.

2. **The Feeder Canal** with a capacity of 16,000 cfs, which will deliver water from the pumping plant discharge pipes to the Equalizing Reservoir.

3. **The Equalizing Reservoir,** formed by constructing earth-fill dams at each end of the upper Grand Coulee, which is 27 miles long, from 1 to 5 miles wide, and has an active storage capacity of 700,000 acre-ft.

4. **The Main Canal,** extending from the outlet works of the Equalizing Reservoir to the head of the East High Canal at mile 7.8. This canal has a capacity of 13,200 cfs, a maximum cut of 90 ft in solid rock, and a bottom width varying from 50 to 120 ft. The Main Canal includes a 23-ft 4-in.-dia. inverted siphon, and a 10,000-ft horseshoe-shaped tunnel of the same diameter. A twin siphon and tunnel will be built when the land placed under irrigation requires additional capacity. At mile 8.0, a potential power site, the water drops 165 ft into Long Lake Coulee, $5^1/_2$ miles of which are utilized as a segment of the canal system. The elevation of this part of the system is controlled by the 111-ft-high Long Lake Dam. From Long Lake to the point where it divides into the East Low and West Canals at mile 20.8, the Main Canal has a capacity of 9,700 cfs.

5. **The East High Canal,** 110 miles long, with 3,100-cfs capacity.

6. **The East Low Canal,** 120 miles long, with a capacity of 4,600 cfs.

7. **The West Canal,** 88 miles long, with a capacity of 5,100 cfs including the Soap Lake Siphon, 12,900 ft long, 22 ft 4 in. to 25 ft in diameter, which will operate under 231 ft of head.

8. **O'Sullivan Dam,** an earth-fill structure approximately $3^1/_2$ miles long, 225 ft high, containing approximately 10,000,000 cu yd of material, which impounds Potholes Reservoir.

9. **Potholes East Canal,** 60 miles long, having a capacity of 3,900 cfs.

Construction of the irrigation system will include the following major items: (1) Four earth-fill dams with a total length of 6 miles and involving $15^1/_2$ million cu yd of embankment; (2) ten tunnels with a total length of 11 miles, for which approximately 1 million cu yd of excavation will be required; (3) forty-six inverted siphons with a total length of 28 miles, for which $1^1/_2$ million cu yd of excavation, 300,000 cu yd of concrete, and 85,000 tons of reinforcing steel will be required; (4) nine principal canal systems with a total length of 500 miles involving 41 million cu yd of earth excavation, $14^1/_2$ million cu yd of rock excavation,

TABLE I. COLUMBIA BASIN CANALS COMPARED WITH NATURAL RIVERS

Canal	Capacity, Cfs	River and Station	Average Discharge,* Cfs
Feeder Canal	16,000	Illinois at Peoria, Ill.	16,510
		Colorado at Lee Ferry, Ariz.	17,300
Main Canal	13,200	Tennessee at Knoxville, Tenn.	13,370
		Willamette at Albany, Ore.	13,740
West Canal	5,100	Connecticut at So. Newberry, Vt.	4,985
East Low Canal	4,500	Snake at Twin Falls, Idaho	4,160

* From Report of National Resources Committee, entitled "Low Dams," Washington, D.C., 1938.

Columbia Basin Waterways

and 2,000,000 cu yd of concrete; (5) lateral systems to serve 1,000,000 acres of land, including several thousand miles of laterals with many appurtenant structures and a considerable amount of lining; (6) twenty-two principal supplementary pumping plants and related work; (7) a large number of miscellaneous features such as bridges, canal structures, pipelines, pumping plants, construction camps, operation and maintenance headquarters, and related works.

Flow Conditions Favorable

The Columbia Basin Project is favored in that it has an abundant supply of irrigation water and in that the peak flow of the Columbia River occurs during the irrigation season, thus assuring both power and water when most needed. The use of the Equalizing Reservoir for storage of pumped water permits the use of off-peak and secondary power generated at the Grand Coulee Dam for the pumping, which is an important factor in the power economy of the Northwest. Another feature of the plan is the collection of return flow from irrigated lands in the northerly area and its re-use farther south. This feature led to the construction of O'Sullivan Dam and the creation of Potholes Reservoir. Large blocks of power, which would otherwise be needed for pumping, are thereby saved, and the saving in construction costs on the canal system is estimated at about $12 million.

In addition to the postwar problems of shortages and rising costs,

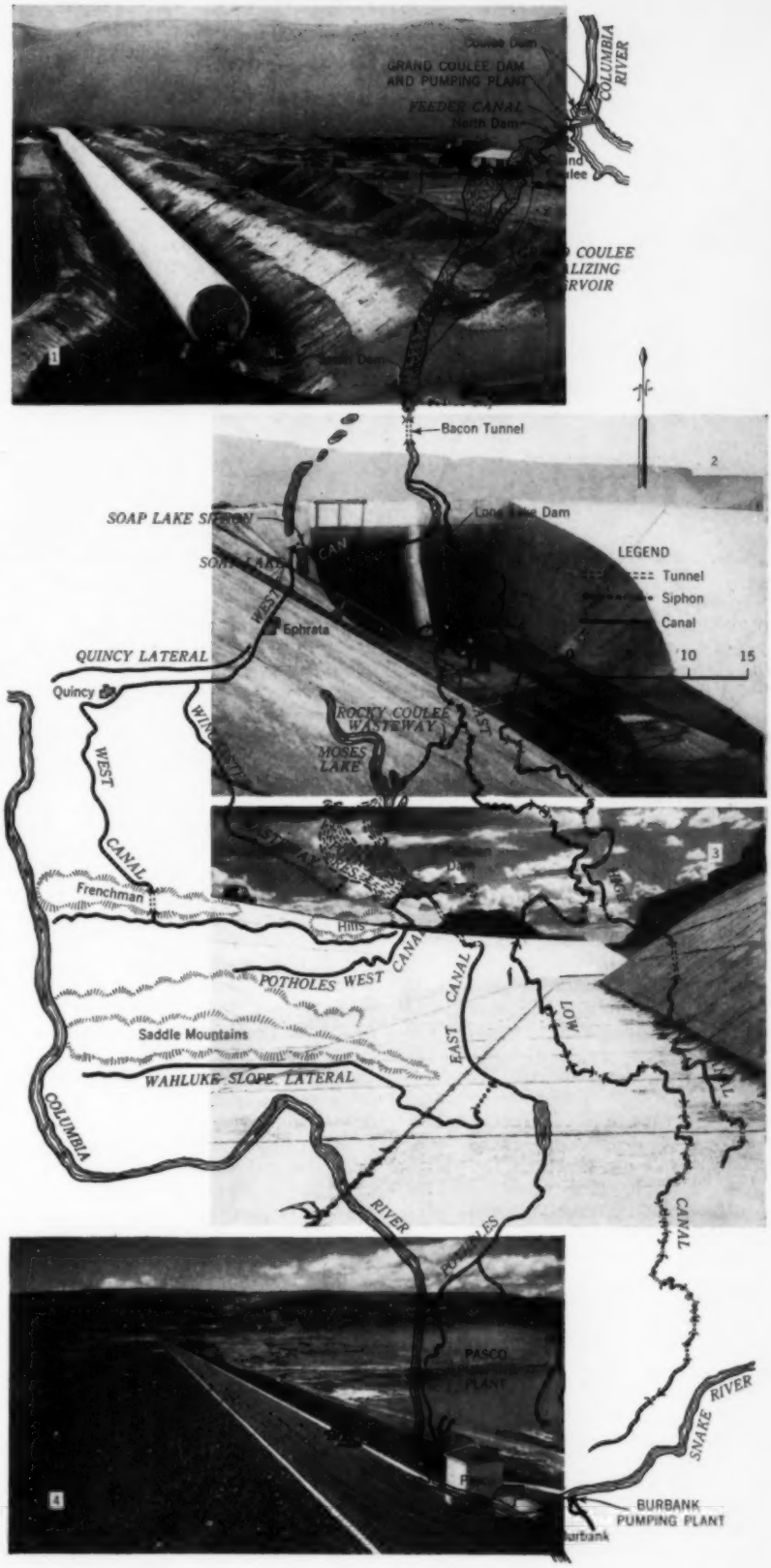

FIG. 1. COLUMBIA BASIN PROJECT in terms of dollars, is about 45 percent complete. Its 500 miles of principal canal systems will irrigate 1 million acres of Columbia River's Big Bend region, and produce 2 million kw of power. Photos in background, reading from top to bottom are: (1) Section of Soap Lake Siphon following trench along northern end of Soap Lake; (2) completed inlet of Bacon Siphon with left inlet bulkheaded, as second barrel will not be built for some time; (3) lined section of Main Canal near Stratford, Wash., of unreinforced concrete, cracking of 4½-in. pavement being controlled by mastic-filled dummy joints. As much as 1,000 ft of this lining was placed in one 8-hour shift; (4) Long Lake Dam, which raises level of Long Lake about 95 ft, thus saving about 6½ miles of costly canal. Reservoir will form on right of dam.

CANAL CHECK divides flow of Main Canal into East Low and West Canals. This structure, with its radial gates, is typical of such structures on Columbia Basin Project.

there have been some construction problems. A major one has been the job of coordinating the planning and development within the basin. Farm units do not consist of the conventional rectangular 40 and 80-acre tracts, but are planned to conform with topography and soil quality. This plan has many advantages, but extensive effort is involved in coordinating engineering requirements with the desires of land owners and with the plans of towns, counties, highway departments, and railroads. Full coordination must be attained before the design and construction program can proceed.

The erratic surface of underlying rock in some of the canals requires extensive drilling and the digging of numerous test pits to furnish the data needed for estimating, bidding, and designing. Extensive subsurface explorations are also required for locating concrete aggregates and suitable borrow material for earthwork. Scarcity of water required for construction activities also has been a problem to contractors.

Much of the upper reaches of major canals will be lined to prevent excessive seepage and canal breaks. The first linings applied to the larger canals were reinforced concrete $4^1/_2$ in. thick. A study and recommendation by a board of consulting engineers led to the elimination of reinforcing steel from the lining. Cracking is controlled by transverse and longitudinal dummy joints filled with mastic.

The concrete mix used for lining a typical canal section was: 38 percent sand; $5^1/_4$ sacks of cement per cu yd; and air entraining agent added at the mixer to entrain 5 percent of air, which with a loss of 1 percent in handling, would give a net of 4 percent in place. The aggregate was unusual in that it was water borne, well rounded and graded, and 100 percent basalt—in fact, very good concrete aggregate.

A buried asphaltic membrane lining will be used in the smaller canals and laterals. This lining is constructed by over-excavating the canal section from 12 to 20 in. After the surface is prepared by dragging and rolling, it is sprayed with a catalytically-blown asphalt. The asphalt is applied at a temperature of about 375 deg F but hardens rapidly because of its high melting point. From $1^1/_4$ to $1^3/_4$ gal are required for each square yard of membrane. The membrane, when cool, is about $^1/_4$ to $^3/_8$ in. thick, tough and flexible, and capable of resisting settlement, heaving, impact, and other abuses without damage. For protective purposes, the membrane is covered to the depth of the over-excavation. Gravelly material is preferred because of its ability to resist erosion.

Extensive studies have been made by the Bureau of Reclamation to find a low-cost canal lining. Buried asphaltic membrane is the best answer found to date. Bids received recently for lining 15 miles of canal resulted in a cost of 68 cents per sq yd, including the cost of over-excavation and refill. This cost compares favorably with the costs of other methods in view of the fact that this was the first large job to be advertised involving the new type of lining.

In terms of dollars, the construction program for the project, including the power development, is about 45 percent complete. Grand Coulee Dam is complete. Of the 18 major generating units, 13 are in operation. The pumping and storage facilities above the Main Canal are about 50 percent complete, and $27^1/_2$ miles of major canals have been finished, as have 3 earth-fill dams, $3^1/_2$ miles of inverted siphons 19 to 25 ft in diameter, and one tunnel 2 miles long and 23 ft 5 in. in diameter. About $125 million worth of construction and supply contracts are in force. The present program contemplates priming the canal system in the fall of 1951 with water being made available for 87,000 acres of new land during the 1952 irrigation season.

When completed, the project, including the power development, will have cost $750 million. It will generate 2,000,000 kw of power and provide irrigation for 1,000,000 acres of dry land. The magnitude and complexity of the various features will have engaged the engineering skill of the Bureau of Reclamation for several decades. The engineering skill which has been applied to the development of this natural resource of water and land will result in providing homes and occupation for an estimated 150,000 people and a consequent broadening of the wealth and tax base of the Northwest and the nation.

The Columbia Basin Project is being built by the Bureau of Reclamation under the supervision of Frank A. Banks, Assoc. M. ASCE, District Manager, Columbia River District.

SOAP LAKE SIPHON will carry water of West Canal around Soap Lake as indicated by dotted line. Structure in lower right is part of West Canal with canal check to right of curve. West wall of Lower Grand Coulee is in background.

Los Angeles Considers Reclaiming Sewage Water to Recharge Underground Basins

From Symposium on Reclamation of Water, Presented at Los Angeles Session of Sanitary Engineering Division

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A LARGE segment of the present population of Los Angeles County, and most of the future growth of the metropolitan area, are dependent upon imported water supplies. The City of Los Angeles solved the problem of providing an adequate water supply for a rapidly expanding population by completing, in 1913, a 233-mile aqueduct with a capacity of 450 cfs from the Owens River in the High Sierra at a cost of $23 million. By 1930, when Los Angeles County contained 2,200,000 people, 44 percent of the population of the state, the need for an additional source of water supply was recognized as a regional rather than merely a community problem, and led to the construction, at a cost of $220 million, of the Metropolitan Water District Aqueduct to tap 1,600 cfs of Colorado River water.

Nevertheless two-thirds of the total water now used in the Metropolitan area comes from groundwater sources. The total groundwater storage available for utilization at economic pumping lifts within this area is estimated at over 4,000,000 acre-ft. However, the growth of population, which reached 4,272,000 in January 1950, and the expansion of industry in Los Angeles County, have resulted in both overdraft on, and declining yields from, the more shallow water zones, necessitating a program of progressive well deepening.

Replenishment of Groundwater Supplies

The metropolitan area of Los Angeles County, which may be described as the area between its mountains and the sea, contains 22 natural underground reservoirs in the form of water-bearing sands and gravels impounded by underground geologic structures. Some of these basins are located in a chain or series; others are independent.

One of the largest basins, the San Fernando Valley, is unique in that it is located entirely within the City of Los Angeles and receives the infiltration of Owens River water used for agricultural purposes, which has kept its groundwater levels fairly high in recent years. The other major basins of the metropolitan area are not so well off as to groundwater replenishment, and some of them pose serious problems.

Both surface and underground water supplies for the West Coastal and Central Basins (areas marked I and II, respectively, in Fig. 1) are derived from the San Gabriel River and its tributaries and from the Los Angeles River and its system. Operation of 14 District flood-control dams, controlling a mountain drainage area of over 400 sq miles and having a total storage capacity in excess of 90,000 acre-ft, has not only reduced flood hazards but, within the limits of safe flood-control operation, has permitted conservation of significant portions of seasonal flood flows for later release to the absorptive stream channels and spreading grounds, which recharge the groundwater basins. In the upper valley areas large peak flows cannot be economically conserved and are lost to the sea.

FIG. 1. LOS ANGELES COUNTY supports population of 4¼ million between mountains and sea in semi-arid region. Groundwater sources, supplying two-thirds of total water use, are being depleted, and two major aqueducts have been built to import distant river water. Storm drains, floodways, ocean outfalls for sewage disposal, and urban development of paved streets and impervious roofs prevent recharge by normal percolation. Uneconomic well depths and sea water encroachment have stimulated proposals to reclaim sewage and flood flows. Water reclamation projects proposed include spreading grounds for flood waters and both spreading grounds and recharging wells for reclaimed sewage in zones marked I and II.

In the West Coastal Basin, the recession in water levels in both shallow and deeper zones has caused the intrusion of sea water which has already advanced 1½ miles inland from the shore line in the vicinity of Redondo and destroyed numerous municipal and industrial wells.

Increase in the consumptive use of water has paralleled the demands of an increasing population and a wide variety of industries. This intensive development has reduced and extent of surface areas formerly available for infiltration of precipitation that provided significant increments to groundwater storage. In addition, the accelerated program of construction of trunk sewers and laterals caused large flows of sewage formerly available for natural groundwater recharge to be lost to the sea. The loss of the large flows of treated sewage effluent, which formerly were a source of recharge for groundwater basins, constitutes a very important but neglected phase of conservation.

In the foothill basins, where a program for utilization of reclaimed water would not be economically feasible because of basin structure and high pump lifts, current overdrafts may be lessened provided measures are continued to conserve local flows by constructing additional water spreading grounds high on the alluvial cones. Ultimately, however, intensive development in such basins will require imported water to supplement the groundwater supply.

Reclamation of Waste Water

Sewage, because of its relatively constant flow, constitutes an important potential source of water for reclamation and spreading. The proposed reopening, as a water reclamation plant, of the Tri-Cities Treatment Plant abandoned in 1948, would again return for percolation in the Rio Hondo channel approximately 9,000 acre-ft of reclaimed water annually. Construction of additional reclamation facilities in the Whittier Narrows area, to treat sewage diverted from the San Gabriel Valley outfall, would permit an initial additional recovery of 10,000 acre-ft of water annually with a potential, when facilities permit, in excess of 50,000 acre-ft annually. The Los Angeles County Flood Control District's Rio Hondo Spreading Grounds of 400 acres could be utilized

RIO HONDO SPREADING GROUND of 400 acres diverts flood waters retained behind dams into basins for recharging underground reservoirs. Temporary diversion dam and intake appear at left; at right, spreading basins are filled with water. Capacity is about 400 cfs of storm water. This is one of ten spreading grounds in use by Los Angeles County Flood Control District.

for spreading the plant effluent, as these grounds have ample capacity.

Experimental tests relative to spreading of sewage-treatment-plant effluents were conducted by the Flood Control District in 1949 at basins adjacent to the Whittier and Azusa sewage treatment plants. It was found that percolated effluents were bacteriologically safe well within a depth of 7 ft from the ground surface; that alternate weekly periods of percolation and of resting and cultivation would be necessary; and that approximately 60 acres of spreading grounds would be required for an initial inflow of 10 mgd of treated effluents, and 300 acres of grounds for a capacity of 50 mgd.

Efforts to prevent further overdrafts in the West Basin have resulted in current proceedings to adjudicate water rights, and in the formation of the West Basin Water District in order to secure membership in the Metropolitan Water District of Southern California which is now furnishing imported Colorado River water to neighboring communities.

Irrespective of any substantial addition to groundwater, there is the necessity for creating a fresh-water barrier along, and inland from, the saline front along the coastal margins to prevent ultimate destruction of the groundwater body in the West Basin. The creation of such a fresh-water barrier would alone economically justify the construction of water reclamation plants and groundwater recharging facilities in the area.

A water reclamation plant may be established adjacent to the sewage treatment plants of the County Sanitation District in Wilmington, and another adjacent to the City of Los Angeles treatment plant at Hyperion. From the Sanitation District plant reclaimed water can be conveyed to the proposed spreading grounds east of Redondo Beach, and perhaps to recharge wells. Effluent from the Hyperion plant can be pumped to proposed spreading grounds nearby.

Reactivation and operation of the Tri-Cities plant to recharge the groundwater body via stream channels is estimated to cost, on a 50-year basis, $9.30 per acre-ft. The average total cost of establishing a 10-mgd reclamation plant below Whittier Narrows and recharging at spreading grounds would be $16.40 per acre-ft on a 50-year basis. For 50 mgd, this cost would be $14.20 per acre-ft. Proposed construction and operation of plant facilities, pipelines and spreading grounds to recharge permeable areas in the vicinity of Redondo Beach would cost $18.00 per acre-ft on a 50-year basis.

Since only limited sections of the county would profit directly from these activities, financing of the water reclamation projects must be assumed by those benefited. Determination of the areas benefited, or more precisely the common areas overlying the groundwater body recharged by specific water reclamation facilities, has indicated the necessity for initial establishment of two water conservation zones or tax districts. Zone I in general covers the Central Coastal Basin, and Zone II includes the West Coastal Basin.

The Flood Control District enabling act of 1915, which delegates responsibilities in the field of water conservation, lends itself to amendments which would permit establishment of water conservat on zones with separate tax structures. Steps toward this objective have been taken and the formation of such tax zones and financing of the water reclamation plans presented here seem an early prospect. These steps, combined with full use of the Colorado River supply, may enable Los Angeles County to stave off water shortages for a decade or more.

Blending of Sewage Effluent with Natural Waters Permits Reuse

From Symposium on Reclamation of Water Presented at Los Angeles Session of Sanitary Engineering Division

A M RAWN, M. ASCE

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RECLAIMING WATER from sewage is not a new idea and the re-use of sewage or sewage effluent for agriculture, industry, and, after some natural purification process, for domestic purposes, is well established. For many years none of the sewage, as such, or the water reclaimed from it, flowed out of the San Gabriel Valley (Fig. 1). It was either returned to the groundwater as drainage from cesspools and leaching grounds, or discharged as oxidized sewage-plant effluent into the stream beds and dry water courses in the valley. The sewage of Chicago provides a large part of the water supply for the lower Illinois River, and the sewage from the cities on the Upper Mississippi River System provides an appreciable part of the water supply for St. Louis, Memphis and New Orleans throughout the year, and a large proportion during the months of low runoff.

In order to explore the possibilities of controlled reclamation of water from sewage and industrial wastes in the Los Angeles metropolitan area, legislative officials in the county ap-

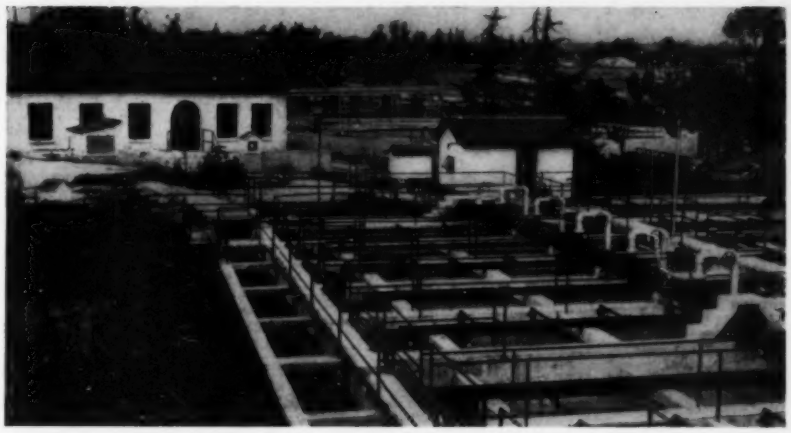
pointed the County Surveyor, the Chief Engineer of the Flood Control District, and the Chief Engineer of the County Sanitation Districts to report on this question. Following a little over a year of investigation and research, a report was prepared which showed current practice in the reclamation of water from sewage here and elsewhere; public sentiment with respect to controlled reclamation; and the relative economics of reclamation versus importation of new water from other watersheds.

Controlled reclamation of water from sewage and industrial wastes must be completely divorced from sewage treatment and disposal if it is to be successful. For instance, if the sewage works is being relied upon as a water reclamation plant and has to reclaim all the plant effluent, there will be occasions when the water reclamation process will be thoroughly degraded and will suffer accordingly. However, if the water reclamation plant is allowed to begin where the sewage treatment works leaves off, it can then select only such part or quality of sewage-treatment-plant effluent as is wholly satisfactory, and at such time as the reclaimed effluent is needed. Such an arrangement, however, implies that there is a final disposal of sewage from the sewage treatment plant whether or not the water reclamation plant is operating. The City of Baltimore offers an excellent example of this arrangement.

Again, if the sewerage system is complete in itself, a water reclamation plant can be located at any point along its main trunks or interceptors, abstracting from the sewers such quantities as are required, purifying the effluent to any desired degree, and returning the residue to the sewer for final disposal in the sewerage system. In a system such as that operated in the metropolitan area of Los Angeles County, such a procedure would be entirely practical.

Some Natural Purification Process Needed

While reclamation-plant effluent may be used directly in some branches of agriculture and in some industries, it must undergo some natural purification process before it loses the stigma which attaches to it for domestic use. It is a perfectly natural twist of human nature to countenance the diversion of many times the total flow from a given stream, each time returning the used water for reuse downstream, and at the same time to summarily reject as inappropriate the re-use of sewage-treatment-plant effluent, even though the latter may be far better than the available raw water supplies. Similarly, there is no aversion or resistance to pumping water from aquifers which are fed in part by drainage from cesspools or sewage treatment works, because of the one step of natural purification which has entered into the process.



PROPOSED REOPENING of Tri-Cities activated-sludge sewage treatment plant would reclaim 9,000 acre-ft per year at estimated cost of $9.30 per acre-ft. This plant was abandoned in 1948, when area served was connected to ocean outfall of Los Angeles County Sanitation District.

Use for Recharging Underground Supplies

A convenient way to avoid conflict with the public feeling of aversion to the direct re-use of reclaimed sewage waters, then, is to utilize the same natural processes of purification now considered acceptable by esthetic and health standards. The recharging of underground water through stream channels and artificially created sand beds has proved economical and satisfactory and will permit the re-use of reclaimed sewage waters on the same unrestricted basis as obtains for present domestic supplies.

While it is entirely possible that the spreading of primary sewage-plant effluent on sand beds will prove to be an acceptable method for recharging underground waters, there are difficulties involved in such a course of action. The principal objection is not the fear of contamination, but rather the likelihood of odor nuisance, mosquitos, and reduced rate of percolation requiring more and larger bed areas or more frequent cleaning. To obviate these objections, it is recommended that the effluent from a water reclamation which is to be discharged onto sand beds for percolation into groundwater be a well-oxidized, secondary effluent such as is produced by a complete sewage-treatment process.

Although "complete" treatment of sewage effectively removes the organic materials from the effluent, the dissolved mineral content of the sewage passes through the process relatively unchanged. Hence it is important that the dissolved mineral loading of the sewage to be used for reclamation purposes be within certain specified limits. In general, sewage from residential and business areas will fall well within the requirements. For example, it is esimated that the water reclaimable from the sewage of the San Gabriel Valley area of Los Angeles County would have the following characteristics: total dissolved mineral solids, 710 ppm; chlorides, 130 ppm; and total hardness, 184 ppm. This water compares favorably with many natural imported and local ground waters.

The extent to which reclaimed sewage waters will be used for agricultural purposes in Los Angeles County may well be a function of the market value of the crops it is proposed to irrigate. The usual conditions of use will require pumping, a lengthy supply line, and an extensive separate distribution system. With crops of high value such as citrus, this use may be economical, but for low-value crops the water costs may be prohibitive. It is essential that the water be applied to the land as required by the crop and not as dictated by the sewage flow.

Use of Reclaimed Sewage Water in Industry

The quality and character of reclaimed sewage waters to be used as industrial supplies will depend upon the processing needs of each specific industry. Direct use of reclaimed sewage water in industry is restricted by public health considerations to those processes where there can be no contact between the reclaimed water and human beings or processed food.

(*Continued on page 89*)

Careful Design Cuts

Construction Costs on Los Angeles Freeway Structures

L. C. HOLLISTER, M. ASCE

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ENGINEERING CONNECTED with the design of freeway structures in a large city is not all stress analysis, the author told the Structural Division at its Los Angeles Meeting in April. Before designs can be started, the requirements of many interested parties must be coordinated, rights-of-way purchased, buildings moved and tenants rehoused, utilities relocated, and plans made for detouring traffic during construction. As structures are frequently on curves, complicated forms are required, and stresses are not susceptible of rigid academic analysis. With architectural advice, the designers have developed a simple unadorned hollow box-girder type of construction—providing an out-of-sight space for utilities—supported by long beams and a minimum of plain columns. Careful detailing has made for simple fabrication and erection of forms and placing of reinforcing steel and concrete. The resulting structures have a clean, well-tailored appearance. Drawings are made with the contractor in mind, to save him time in taking off quantities for bidding and to minimize mistakes.

TO RELIEVE the continually growing traffic congestion in the Los Angeles area, the California State Division of Highways is spending many millions of dollars on freeway construction. The Arroyo Seco Freeway has been open for several years; a section of the Santa Ana Freeway has been open for some time; and the Hollywood and Harbor Freeways are under construction.

A Complex Engineering Problem

The total engineering problem in connection with the design, construction, and maintenance of a freeway is complex. The amount of preliminary investigation and planning for a freeway structure in the heart of a city like Los Angeles is tenfold that required for an ordinary bridge in a peaceful rural area.

Many factors enter into the selection of a freeway location and the most desirable location may not be the cheapest either from the construction or the right-of-way standpoint. The whole design procedure becomes one of cut and try, of compromises from start to finish. Geometric design must be worked out with right-of-way problems, and architectural treatment must fit in with economic and structural requirements until a satisfactory layout and design have been attained. Since freeway structures usually involve city streets, the city's engineers must be consulted as to future street developments.

After weighing the requirements of bridge design, highway design, city street design, and right-of-way, a definite alignment, grade, and roadway width can be established. In addition, requirements for storm drains, telephone lines, gas lines, power lines, police and fire signals, and street car and interurban facilities must be considered so that each of the affected agencies can prepare its plans both for permanent installation and for temporary service during construction.

Then come the problems of detouring existing traffic and determining the best order of construction with respect to adjacent jobs so as to inconvenience street traffic as little as possible. Since bridge structures can best be built ahead of freeway grading, a small amount of approach freeway grading or connecting street work is necessarily included in each bridge contract, which requires further coordination and planning between agencies.

Hollywood Freeway Structures Completed

On the $3^1/_2$-mile stretch of Hollywood Freeway extending from the Los Angeles Civic Center westward to Vermont Street, the bridge structures are completed and grading and paving projects are under way. In this section there are approximately 33 highway separation structures and 3

THIRTY-THREE grade-separation structures have been constructed on Hollywood Freeway between Los Angeles Civic Center and Vermont Avenue. Note four-level intersection with Harbor Freeway just left of center at lower edge of panorama on this page. Sketches are by architect, H. C. Van der Goes.

pedestrian crossings, which vary in span from 38 to 143 ft. The 143-ft span, where the Santa Monica Freeway joins the Hollywood Freeway, is the longest concrete girder span in the state. The separation structures are generally of the box-girder type and range in unit cost from $9 to $26 per sq ft of roadway surface. The most complicated is the four-level crossing of the Arroyo Seco–Harbor Freeway with the Hollywood Freeway, which cost $1,065,654, or $10.09 per sq ft.

Detailed data on costs are not yet available but the approximate cost of the structures in this 3½-mile section is $7,500,000, or in the neighborhood of $2,100,000 per mile. The roadwork excavation, erosion protection, paving and other construction items will come to about $4,900,000. In addition, right-of-way will cost around $7,200,000. Thus the total cost will be about $19,600,000 or $5,500,000 per mile.

Right-of-Way Is Important

Right-of-way problems in connection with a downtown freeway project are important and require painstaking attention. On this 3½-mile stretch, 810 parcels of real estate were purchased, including such types of property as schools, churches, apartments, a large assortment of business establishments, and many homes both large and small. In this area 9,200 people were moved from their homes without a single eviction, and during a period of critical housing shortage. Houses were sold under contract with the provision that the successful bidder must move the dwellings intact to a suitable location and give the occupants a 6-months' lease. If a building was of such a type that it could not be moved, then the contract called for finding suitable homes for the occupants before demolition.

Continuous Box-Girder Design Adopted

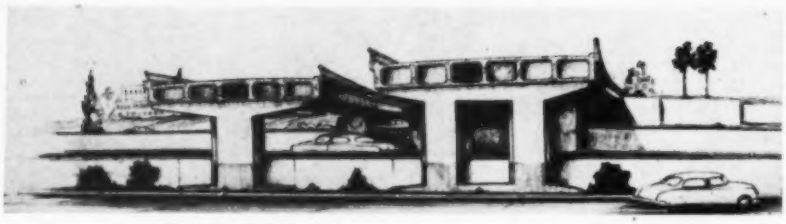
This section of the Hollywood Freeway will carry approximately 100,000 cars a day at the maximum legal speed of 60 mph. Alignment, sight distances and grades have been laid out for safety at higher speeds with less traffic, but as the volume of traffic increases the safe driving speed declines. The "on" and "off" ramps are theoretically designed for 70 percent of the freeway speeds.

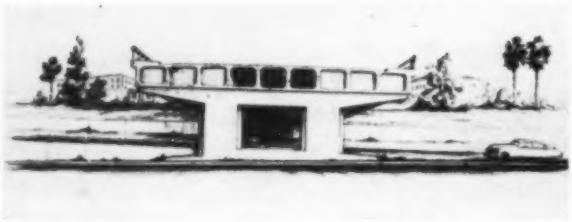
This section of freeway has been designed in accordance with the highest standards of the American Association of State Highway Officials. Likewise, each of the structures has been designed in accordance with the latest AASHO design specifications for highway bridges which provide for an H20-S16 loading with basic concrete design stresses at 1,000 psi and structural steel at 18,000 psi in tension. In January 1950 the allowable working stress in concrete was raised from 1,000 to 1,250 psi for the box-girder type of structure in the Los Angeles area. This increase was allowed for two reasons: (1) This type of structure has an inherent stiffness which justifies higher stresses; and (2) concrete cylinder tests in the area have demonstrated that an ultimate strength of 4,000 psi for concrete can reasonably be expected.

The box-girder type of structure adopted appears to be particularly suited to freeway construction in the Los Angeles area for several reasons. The freeway crosses under many very busy streets in the downtown area, all of which are underlaid with numerous utilities. These facilities must all be provided for in the construction of the freeway, and in most cases the logical solution is to carry them across the freeway on the structure. The hollow-girder design with the boxed-in areas between girders makes an ideal out-of-sight location for these utilities.

Maximum Architectural Appearance

In addition, these structures with their smooth soffits make it possible to provide the maximum in architectural appearance. Because the top and bottom slabs increase the stiffness and torsional resistance of the girder stems, the girders can be built on rather sharp radius curves, making the structure conform to the curvature, changing superelevation and parabolic grades of the curved ramps. Because of the flexural stiffness thus provided, the girders can be built in relatively long spans with comparatively shallow depths. This saving of from 6 to 12 in. in the depth of the structure saves an equivalent depth of excavation over a large freeway area.





MOST FREEWAY STRUCTURES are continuous box-girders supported on bents which bend with superstructure. Boxed-in areas provide out-of-sight space for utilities. Fourth Street Overcrossing (top), Third Street ramp (left), and typical boxed retaining wall (lower left) are all on Harbor Freeway but are characteristic also of Hollywood Freeway construction.

Another advantage to having a bottom slab is that it provides ample area in which to place reinforcing steel. It is structurally satisfactory and desirable to spread the tension steel out in bottom slabs for positive moment and in top slabs for negative moment.

Since the steel is not located within the stem, it is not possible to bend bars up near supports. Shear reinforcement therefore is provided entirely by stirrups—an advantage to the reinforcing fabricator and erector because all the heavy, main reinforcing bars are straight, and are easily fabricated, shipped and placed.

An exact and academic method of analysis for computing the stresses in these structures is not available. Most of them are of the continuous-girder type supported on bents which bend with the superstructure. In some cases, they are single-span reinforced concrete box-girder frames. In either case they are of the indeterminate type, which means that final stresses due to applied loads will depend on the relative flexural qualities of the beams and columns. Since an exact moment of inertia, upon which the flexure depends, cannot be determined, the designer must make certain assumptions as to the moment of inertia at the beginning of the structural analysis.

Some Wedge-Shaped Spans

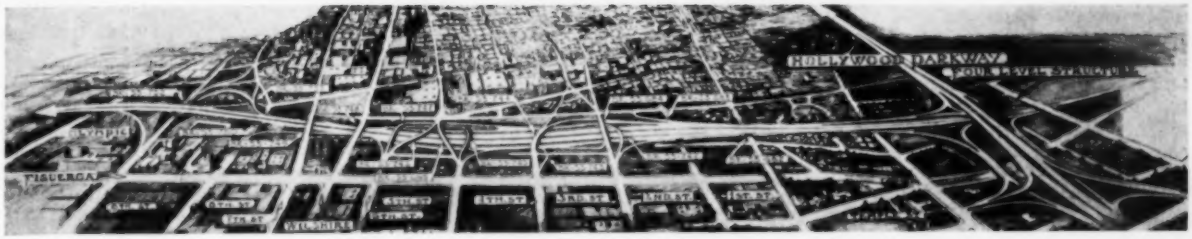
Not only are many of the structures skewed, but in some cases adjacent bents are skewed at different angles, making wedge-shaped spans, with the girders on one side longer than those on the other side. Also, some of the structures are on sharp curves with the girders built on a curve to conform to the alignment. In some cases torsional reinforcement has been added for curved girders; in most cases, however, the inherent stiffness of the box-girder type has been relied upon to resist torsional moments without the use of additional reinforcing.

Load transfer to foundation material consists in general of three types, depending on the depth to bed rock: (1) Footing foundations on bed rock at $2^1/_2$ to 5 tons per sq ft, (2) bearing piles to bed rock, or (3) friction piles penetrating to a depth determined by the Engineering-News formula.

Four-Level Structure Has Complicated Layout

The four-level structure located where the Arroyo Seco–Harbor Freeway crosses Hollywood Parkway has a complicated layout, the design answers to which could not be found in any textbook. It required good engineering judgment in the design of details for which there were no

SINGLE-COLUMN BENTS and curved and superelevated roadways require good engineering judgment in design since they have no rigid academic precedents. Typical example is Third Street ramp on Harbor Freeway.



HARBOR FREEWAY passes under Hollywood Parkway at four-level crossing at right in sketch above. At right of this crossing, Harbor Freeway continues as Arroyo Seco Parkway to Pasadena.

precedents. Its first story is at ground level and does not affect the design except in the location of the columns which support the three stories above.

The second story carries the Harbor–Arroyo Seco Freeways. The superstructure at this level is a continuous slab 415 ft long and 94 ft wide, without expansion joints, supported on columns and caps. The slab spans vary from 40 to 52 ft. The particular concern here was whether such a large slab would be structurally sound without expansion and contraction joints. The short supporting columns were hinged top and bottom to act as deep rocker supports. Horizontal stability was obtained by anchorage to the large columns near the center of the structure.

The third story is of box-girder construction supported on columns and caps. Built without expansion joints, this story is the shape of an enormous "X" which measures about 365 ft from tip to tip. The design of this story is without precedent, and the framing of girders, caps and columns is so cut up that it does not lend itself to any exact academic analysis. Each line of girders has a different moment of inertia and different span length from those of the adjacent girders which must deflect with it.

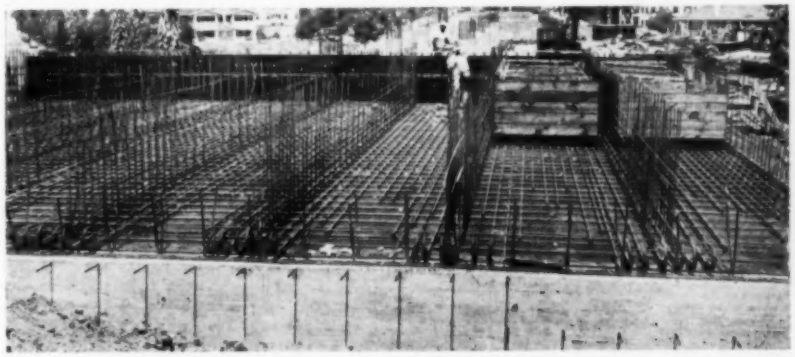
The fourth story, which carries the Hollywood Freeway and is approximately 65 ft above the ground-level interchange lanes, is a reinforced concrete box-girder type 575 ft long, built in two halves each 43 ft wide, and joined by three heavy caps near the center. Here also, the entire superstructure is built without expansion joints except at the ends. Short columns near each end are hinged top and bottom to act as large rockers.

The choice of this structure instead of the conventional four-leaf-clover grade separation was a compromise between right-of-way costs and structure costs. By the use of more land, the same facility could have been provided with structures only two stories high instead of four, but right-of-way costs would have been greatly increased. There were other factors, such as the location of existing streets and main boulevards, and the handling of traffic during construction. The job is believed to be economically and structurally sound. It is our best answer to a tough problem.

Good Design Saves Dollars

What is being done to further reduce the cost of these structures? While it is possible to reduce costs to some extent by a closer and more refined analysis of stresses, greater economy can be obtained by more careful selection of details that are simple to build.

The cost of Class "A" structural concrete for structures such as those in the freeway has gone up from an average of $18.50 per cu yd in 1940 to about $45.00 per cu yd in 1950. The increased cost of the concrete itself delivered to the job accounts



ON TYPICAL box-girder bridge job (right), bottom-slab and girder stem steel is in place and wooden forms for cellular openings are being set. Box-girder spans 101 ft long, with heavily reinforced concrete columns of 5-ft 6-in. diameter, carry Hollywood Freeway over Heliotrope Drive (below). Roadway excavation under structure has not yet been made. Record-length box-girder spans are 143 ft long, used near Vermont, where Hollywood Freeway crosses Santa Monica Parkway.

for only a few dollars out of the $27 rise. Since the main part of the increase is in forming, placing, and finishing, it is in these operations that the largest savings can be made by preparing details that will enable the contractor to reduce labor costs.

Solid Abutment Legs Used

A few years ago in designing these single- and double-span box-girder frames it was customary to make the abutment legs of the cellular type also. Experience soon revealed, however, that solid or slab-type abutment legs were actually cheaper to build in spite of the additional concrete and reinforcing steel needed. Formwork is much cheaper, reinforcing steel is much more quickly and easily erected, and concrete is more cheaply placed. These savings are particularly noticeable on skewed structures, of which there are a great number and for which formwork is very expensive. Likewise, the simple-slab cantilevered type of retaining wall is cheaper than the more intricate detailed counterfort type.

Much attention is given to the inside dimensions and details of the boxed sections in order to reduce the cost of forms. Inside form dimensions are kept nearly constant for possible re-use of forms. A web spacing of 8 to 9 ft, providing for a minimum slab thickness of about 6 in. has been found the most satisfactory and economical. Girder stem and diaphragm thicknesses were held to a minimum of 8 in. Since formwork on curved and skewed structures is complicated and costly, the contractor is permitted to form girders either on the curve or on chords approximating the curve, except that outside faces of outside girders must match the radius of curvature. Adoption of standards for as many features as possible helps reduce costs. Therefore steel railings, drain details, reinforcing systems, and expansion dams have been standardized as far as possible. The contractor and his personnel are kept in mind when preparing detailed drawings. Many bids are received on each job. Each bidder must go through the plans and take off quantities and figure costs. Well-prepared definitive plans and specifications make it easy to take off these quantities and reduces possibilities of errors.

As bridge contractors become familiar with the plans and standards of construction, they can figure construction costs more accurately on each new job. Contractors are thus encouraged to come back for more jobs and competition is increased. Practically all the contractors who are bidding on and building the freeway structures have been doing so successfully for a number of years.

Simple Horizontal Lines Emphasized

Bridge engineers throughout the country have made wonderful strides in the improved architectural appearance of their bridges in the last ten years or so. Most advancement along this line has been made because the engineer has come to realize that the architectural treatment of a bridge, if it is to be done well, must be done by a competent architect. The Bridge Department of the California Division of Highways is fortunate in having a sufficient volume of bridge work to make it worth while to employ a full-time architect, and the sketches which illustrate this article have been made by him, H. C. Van der Goes.

Special Study Given Each Structure

Because of the importance of these freeway structures, each one is given special architectural study. First the engineer makes several preliminary studies to determine the type of structure by studying possible span lengths, arrangements, pier layouts, and other features, and from these studies selects the most feasible layout from an engineering standpoint. The architect then studies the proportions, treatment of piers and abutments and other general architectural features. While architectural treatment is often a matter of opinion, there is a definite departmental objective of having structures neatly groomed and well tailored, with pleasing proportions, simple lines, and freedom from pretentious filigree.

Since the flow of highway traffic is horizontal, the architect feels that the horizontal lines should be accentuated and the vertical lines minimized. For the full development of this idea, the architect has suggested the omission of as many columns as possible. The result is the construction of more and more single-column bents, or in the case of very wide roadways, the construction of multi-column bents with unprecedentedly long cap-spans between columns.

A good example of the latter occurred on the Hollywood–Santa Monica Freeway separation structure. Here the structure crosses on a 68-deg skew and requires a 143-ft reinforced concrete box-girder span. Supporting this long span is a two-column bent with columns spaced at 59 ft. This long cap-span supporting the heavy reactions from 143-ft girders required the design of an unprecedentedly heavy cap. The design of this cap required a reinforced concrete girder 8 ft wide and 9 ft deep, with such a large amount of steel that the $1^1/_4$-in. square reinforcing bars had to be bundled together in groups of four to make room for the contractor to place the concrete.

This part of the Hollywood Freeway is planned for completion in 1951. Construction of the Harbor Freeway will start this spring.

HOLLYWOOD FREEWAY passes over Figueroa Street on center structure and over Harbor Freeway at four-level crossing in left background. At this point Figueroa Street and Harbor Freeway run almost parallel.

...THE READERS Write

Professional Man Gets His Greatest Satisfaction from Work Well Done

TO THE EDITOR: Donald M. Baker's article, "Is the Practice of Engineering a Profession or a Business?" in the March issue was most stimulating. We engineers need to be stirred up a bit to make us realize that, if the professional attitude is to be maintained, the profit motive must be subordinated and the pride of achievement in doing good technical work must be emphasized.

Such a professional attitude can be developed and encouraged both by the so-called leaders of the profession and by engineers in subordinate positions, whether they are in public service, in industrial work, or in private practice. Perhaps this can best be done by seeking employment where the profit motive is subordinated and eschewing it where the aim is primarily to get out the work rapidly and cheaply, without much regard for technical niceties. For example, a young engineer interested in strengthening professional standards might be unwilling to work where stock plans are used instead of new, up-to-date, carefully worked out designs prepared to fit the individual case.

Such maneuvers may savor of labor union tactics but in other professions similar activities involving moral suasion are the order of the day and have certainly improved the standing of the legal and medical professions.

Even the capable, successful engineer must be largely compensated by the glow of satisfaction that comes from having performed his work in a really professional manner rather than by the limited monetary rewards he may enjoy. Most of the capable engineers of mature years that are known to me could gain far greater dollar rewards if they transferred their activities to a strictly business field.

As a matter of common horse sense, it appears that an engineer should either make of himself a professional man or should leave the engineering field and enter some other field where his administrative ability, his technical knowledge and his aptitudes will gain him more substantial rewards if not equal satisfaction.

ARTHUR W. CONSOER, M. ASCE
Consoer, Townsend & Associates
Chicago, Ill.

USBR Report Throws Light on Sedimentation of Elephant Butte Reservoir

TO THE EDITOR: In his article, "Aggradation in Rio Grande Valley Affects Sedimentation of Elephant Butte Reservoir," in the February issue, J. C. Stevens presents an excellent discussion of the 1947 report of the Bureau of Reclamation on its resurvey of Elephant Butte Reservoir, but the validity of some of his conclusions is questioned.

Mr. Stevens points out that the results of the Bureau's survey confirm estimates made in his paper in the 1946 ASCE TRANSACTIONS. However, with regard to the movement of unmeasured sediment load into the reservoir, it should be emphasized that the Bureau's report concluded that this should amount to between 15 and 25 percent of the total sediment load. Thus Mr. Stevens' average weight of 65 lb per cu ft of deposited sediment represents about the lowest estimate of probable weight.

Mr. Stevens indicates that he believes that the Bureau's estimate of sediment contribution from streams directly tributary to the reservoir is low. The estimate was arrived at by measuring delta deposits of sample tributaries and applying the results to the whole area directly tributary to the reservoir. It should be pointed out that while the delta deposits do not contain some of the fine materials brought down by the tributary streams, they do contain some of the fine materials carried by the main river. The Rio Grande Project Office, in reviewing the Bureau's report before its release, was of the opinion that, if anything, the estimates of the contribution of tributary streams were high.

The material deposited in the reservoir by the tributaries is coarse and heavy and probably weighs about 90 lb per cu ft. Thus a 0.42 acre-ft per sq mile per year contribution would give a weight of about 800 tons per sq mile per year, or about one-half of Mr. Stevens' estimate of 1,600 tons per sq mile per year.

Two errors were made by Mr. Stevens in computing the total sediments contributed between Cochiti and Elephant Butte Dam. First, he failed to deduct the sediment load of the Rio Grande at Cochiti, and second, he did not recognize that the estimates for the rate of deposition on the valley floor (1936 to 1941) and for the rate of deposition in the reservoir (1915 to 1947) are not concurrent and that actually valley-floor deposition has, to a certain extent, replaced reservoir deposition. Because he clearly states that such is the case, it is concluded that the second error was on oversight on his part.

If these two errors are corrected, the total sediment load of the Rio Grande between Cochiti and San Marcial is estimated to be about 22,000 acre-ft per year, of which about 6,000 acre-ft per year are estimated to originate above Cochiti.

It is not conceded that Mr. Stevens has reached a valid conclusion in his last paragraph wherein he states that a period of degradation in the Rio Grande Valley can be expected some time in the future. It is very doubtful if such an expectancy will be realized unless the sediment load of the Rio Grande decreases markedly or unless the runoff from the mountain tributaries is above average for a considerable number of years.

It should be remembered that the virgin flow of the Rio Grande at San Marcial has been depleted, through beneficial and non-beneficial consumptive use, by at least 500,000 acre-ft per year. Assuming that the sediment load of the stream has remained the same for the past 70 years, the result is that there is an insufficient supply of water to carry the sediment brought to the stream by the major sediment-producing tributaries. Under such conditions it should be expected that the river would continue to aggrade until it became steep enough to carry its load of sediment.

However, sediment deposition in the Rio Grande seems to be accompanied by a heavy growth of vegetation and an increasing non-beneficial consumptive use of water, factors tending to increase the slope of the stream needed to carry its sediment load. These factors, together with the steep slope of the stream (4 to 5 ft per mile) and the large area available for storage of sediment, lead to the inevitable conclusion that the cultivated area of the Middle Rio Grande Valley long will have been destroyed before the river becomes adjusted to its present load and discharge and again moves its full sediment load into Elephant Butte Reservoir.

THOMAS MADDOCK, JR.
Head, Sedimentation Section,
Hydrology Division, U. S.
Bureau of Reclamation
Denver, Colo.

Fixed End Moments Found Without Handbook Formulas

TO THE EDITOR: No formula for determining fixed end moments in a beam with trapezoidal loading can be found in handbooks, Elihu Geer, M. ASCE, stated in his article in the July 1949 issue. This omission, however, is not very serious as the exact fixed end moments for this case, Fig. 1 (*a*), can be easily obtained by combining two loading conditions such as shown in Fig. 1 (*b*) and (*c*).

The coefficient of WL for the loading shown in Fig. 1 (*c*), as given in handbooks, is:

$$\frac{a\,(10 - 10a + 3a^2)}{30} + \frac{a^2(5 - 3a)}{30} = \frac{2a - a^2}{6}$$

Assuming numerical values of q = 1.0 kips per ft; c = 3.0 ft; and L = 16.0 ft, it follows that $a = {}^3/_{16} = 0.187$, and the coefficient,

$$\frac{2a - a^2}{6} = \frac{2 \times 0.187 - 0.187^2}{6} = 0.565$$

Accordingly, the fixed end moment is

$$0.0565WL = 0.0565 \times 1.5 \times 1.0 \times 16.0 = 1.34$$

The fixed end moment for the beam in Fig. 1 (*b*) is obviously

$$\frac{ql^2}{12} = \frac{1.0 \times 16.0^2}{12} = 21.4 \text{ kip-ft}$$

and the fixed end moment for the combined loading is

$$21.4 - 1.34 = 20.06 \text{ kip-ft}$$

The formula given by Mr. Geer for fixed end moments of the beam with trapezoidal loading is

$$\frac{q}{12L}\,(L^3 + c^3 - 2Lc^2)$$

Substituting the assumed numerical values,

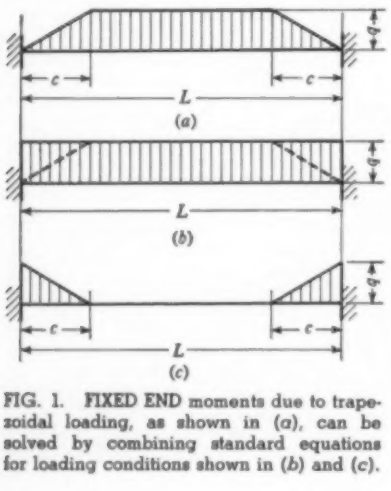


FIG. 1. FIXED END moments due to trapezoidal loading, as shown in (*a*), can be solved by combining standard equations for loading conditions shown in (*b*) and (*c*).

$$M_f = \frac{1.0}{12 \times 16}\left[16^3 + 3^3 - (2 \times 16 \times 3^3)\right] = 20.0 \text{ kip-ft}$$

which checks with the value of fixed end moment previously obtained.

This formula is only applicable to a symmetrically loaded beam. The method of separating a given loading into component parts, however, is general and the problem can be solved in most cases by formulas readily found in handbooks. Since it is easy enough to compute the exact values of fixed end moments in beams with a loading of this kind, there is little if any advantage in resorting to equivalent loadings, which also must be computed and which at best give only approximate results.

A method of finding fixed end moments in beams for any kind of irregular loading is outlined in *Continuous Frames of Reinforced Concrete*, by Hardy Cross and N. D. Morgan, page 84. The method, which is entirely independent of handbook formulas, makes use of false reactions which are computed by the familiar method of moment distribution and applied to the beam as concentrated loads. The moments at the ends of the beam, obtained in each of the two steps, are added algebraically and represent the fixed end moments of the beam at each end. To use this method it is necessary to remember the formulas for only three fundamental conditions of loading, which are illustrated in Fig. 2.

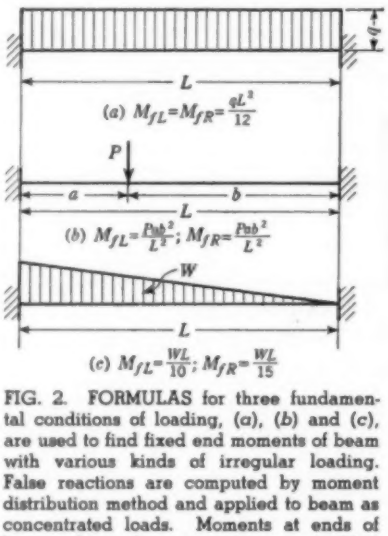


FIG. 2. FORMULAS for three fundamental conditions of loading, (*a*), (*b*) and (*c*), are used to find fixed end moments of beam with various kinds of irregular loading. False reactions are computed by moment distribution method and applied to beam as concentrated loads. Moments at ends of beam, obtained in two steps, are added algebraically to give fixed end moments at each end of beam.

JOSEPH ZALKIN, Assoc. M. ASCE
Engineer, Corps of Engineers
Washington, D.C.

Designation of Author Corrected

In the foreword to the article by Robley D. Stevens, "Can You Prove 'Professional Exemption' Under Fair Labor Standards Act?" on page 27 of the April issue, it was stated that Mr. Stevens is a lawyer. In a recent letter Mr. Stevens says: "I am not a lawyer, nor a member of the bar and have never practiced as one."

The editor willingly withdraws the statement that Author Stevens is a lawyer and regrets being the possible cause of embarrassment to him.

Housing Progress Due to N.Y.C. Housing Authority

TO THE EDITOR: Many fine things were said about the New York City Housing Authority in Francis M. Tompkins' article, "Simplification Can Save Money on Government Buildings," in the February issue. There is one statement, however, that should be clarified. Certain principles which are effective in obtaining speed and economy in monumental building construction were listed and it was stated that:

"These principles were initiated in 1941 by the Citizens' Housing Council of New York headed by Dr. Jacob Feld, M. ASCE,* and have been applied under the New York Housing Authority. Because of their direct bearing on the subject at hand, parts of the Citizens' Housing Council report of 1941 are paraphrased below," and, "By the adoption of these recommendations, by standardization, by simplification and by designing for mass production and repetitive methods within each project, the New York City Housing Authority has produced housing equal to or better than other housing in the country in quality of construction."

A reference to the report of the Citizens' Housing Council shows that these are general recommendations made by a special committee set up to study construction cost economy for large-scale housing projects. Practically every one of the items cited as valuable for this purpose was in use by the NYCHA several years prior to the preparation of the report by the Citizens' Housing Council. It must be apparent, therefore, that rather than the Housing Authority's adopting recommendations by the Citizens' Housing Council, the reverse is the case. I believe that in all fairness this situation should be recognized, without

* EDITOR'S NOTE: Dr. Feld was not head of the Citizen's Housing Council but Chairman of the Committee on Construction Cost Economy which prepared the February 1941 report referred to. See Dr. Feld's Letter to the Editor, March 1950 issue, page 50.

detracting in any way from our sincere appreciation of the many fine things Mr. Tompkins said about the Authority.

JOHN P. RILEY, M. ASCE
Director of Development, New York City Housing Authority
New York, N.Y.

TO THE EDITOR: In my article in the February issue, it was not my intention to detract in any way from the efficient job done by the New York Housing Authority in designing more economical housing. The sentence quoted by Mr. Riley is undoubtedly misleading.

I did not intend to imply that these principles were initiated solely by the committee headed by Dr. Feld, or that the New York Housing Authority did not produce economic housing prior to this report. That report set forth, more concisely and clearly than any other document I had seen, some of the principles which I felt were necessary to accomplish economy in construction. My intention was to compliment the New York City Housing Authority on its outstanding success in designing economic housing and in carrying it to completion.

FRANCIS M. TOMPKINS,
Assoc. M. ASCE
Chas. H. Tompkins Co.
Constructing Engineers
Washington, D.C.

Concrete Cylinders Tested in Compression Show "Elastic" But Not "Plastic" Range

TO THE EDITOR: With reference to my article in the April issue, page 29, entitled "When Concrete Becomes Discrete," a rather serious mistake occurs in the subtitle, where the existence of any *elastic* range in concrete cylinders subjected to axial compression tests is denied. It was not my intention to make any such denial. What I wished to deny was that there is any *plastic* state or range of the concrete. This same erroneous statement that there is no *elastic* range occurs in the first sentence of the caption for the photographs of cylinders after testing at the top of page 29. On page 31, middle column, seventh line, the reference should be to Fig. 3 instead of to Fig. 2.

The view I intended to present is shown by the revised Fig. 1, here reproduced.

HOMER M. HADLEY,
M. ASCE
Seattle, Wash. *Consulting Engineer*

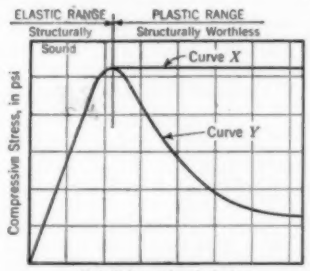


FIG. 1. TWO TYPES of stress-strain curves, *X* and *Y*, represent theories proposed for behavior of concrete in compression. Curve *X* extends horizontally into the so-called "plastic range" beyond point of maximum stress which terminates so-called "elastic range." Curve *Y* descends and flattens as it extends into so-called "plastic range." Curve *Y* gives authentic record of prolonged cylinder test but fails to show point where fragmentation occurs. No resemblance to curve *X* was found in tests here described.

Value of Snow Surveys Shown by Long Experience

TO THE EDITOR: Considering the importance of water supply in the West and the need for good forecasts of runoff, the value of snow surveys should not be underestimated. Having been chairman of the forecast committee of the Nevada Cooperative Snow Surveys for 20 years (1928–1947) and associated with Dr. Church in this work for some years before that, I was naturally much interested in Kristian Tonning's article in the October 1949 number and in the letter to the editor on it by Walter T. Wilson in the January 1950 issue.

An indication of the value of snow surveys is the fact that irrigation districts and power companies in Nevada and California for many years have depended on forecasts made from these surveys. There are now 125 public and private organizations which realize the value of this work sufficiently to cooperate and profit by the results.

The effort and time involved in snow surveying and also the cost, would be greatly decreased by the use of helicopters to transport surveyors to the snow courses. This practice has already begun and will no doubt become general in a few years.

Analysis of 40 years of snow surveying in Nevada, where Dr. Church developed the first practical method of sampling deep snow, has shown the value of such surveys in forecasting runoff. This study, "Snow Surveys for Forecasting Stream Flow in Western Nevada," appears in the Nevada Agricultural Experiment Station Bulletin No. 184. In my work on this bulletin I found that for every snow course with a record of 15 or more years, it is possible to obtain a good straight-line graphical relationship between the water content of the snow and the stream flow, with very few of the years more than 15 percent away from the line. The few cases of greater deviation can usually be explained by abnormally high or low precipitation during the April–June runoff period, after the early April forecast, or in some cases in the previous fall.

Another study showed that a single fixed location for sampling on a snow course does not represent an area adequately in different years. An average of 10 to 20 samples spaced at 25- or 50-ft intervals yields a much better determination of the snow's water content. The paper on this study, "The Value of an Individual Sample in a Snow Course," was prepared under my direction by Claude E. Hunter and George W. Devore, senior civil engineering students at the University of Nevada, and published in the *Transactions* of the American Geophysical Union, July 1937, Part II. Data from field notes on 12 different courses were analyzed for periods of 12 to 15 years.

With a single, well-located snow course it would be possible some years to make a good forecast, but since the distribution of heavy storms is not always the same, it is better to use several courses and develop a system of weighting them according to their importance, usually determined on the basis of water content. It is not at all necessary to estimate the total water content of the snow blanket covering a basin. Even if such an estimate were possible, it would not tell how much would run off, since absorption losses for a whole basin are practically indeterminate and vary greatly in different years.

In 1935 the federal government came into snow survey work officially when Congress made an appropriation to enable the Division of Irrigation of the Soil Conservation Service to coordinate the work, cooperating with agencies already carrying on snow surveying and expanding it to reach all appropriate regions in the western states from the Rocky Mountains to the Pacific Coast.

For the last seven years the U.S. Weather Bureau has been publishing stream-flow forecasts for the full water year, October 1 to September 30, for numerous western streams, increasing the number each year. The first forecast is dated January 1 and they follow at monthly intervals until May 1. Five choices or "guestimates" are listed, and

(*Continued on page 87*)

SOCIETY NEWS

For Proceedings Abstracts and Order Blank, See Pages 101–102

Toronto Is Setting for ASCE Summer Convention

ENGINEERS AND THEIR families planning to attend the 78th Annual Convention of the Society, to be held in Toronto, July 12–14, in conjunction with a convention of the Engineering Institute of Canada, will find the city a happy choice for a summer meeting. Scenically located on Lake Ontario, Toronto offers the unusual combination of a large, modern, highly industrialized city in a forest setting famed for its sightseeing and recreational opportunities.

Joint Program with EIC

The technical side of the program will consist of sessions of several of the ASCE Technical Divisions, which will feature significant engineering developments in both countries. Already scheduled are meetings of the City Planning, Power, Air Transport, and Waterways Divisions. In addition, tentative plans are being made for one or more sessions of the Construction, Highway, Irrigation, Sanitary, Soil Mechanics and Foundations, and Structural Divisions. A number of the Technical Division meetings planned will be cooperative sessions with the EIC. To supplement these sessions, EIC committees, headed by Austin Wright, M. ASCE, general secretary of the Institute, are arranging inspection tours to various engineering and industrial projects in the Toronto area. The complete program of speakers and their subjects, trips, and social events will be printed in the June issue of CIVIL ENGINEERING.

One of the leading cities of the Dominion in point of population, invested capital, and industrial production, Toronto has thousands of subsidiary plants of United States and British industrial organizations, as well as a large concentration of Canadian companies. Narrow downtown streets and ancient buildings, juxtaposed with modern developments, give an idea of the history of the city through its long years of colonial development.

Sightseeing Opportunities

Of interest from a sightseeing point of view are Old Fort York, one of the few colonial fortifications on the continent existing in its original form; the Parliament buildings for the Province of Ontario, which afford a glimpse of the panoply and trappings of the Parliaments on the Thames; the Royal Ontario Museum, famous for its collection of Chinese art, including a Ming Dynasty tomb; and the Canadian Exhibition buildings.

Summer Convention visitors will also want to see the University of Toronto, center of much of the cultural life of the city; the Connaught Laboratories, which grew out of the discovery of insulin at the University of Toronto; Canada's internationally famous Institute for the Blind; and numerous other landmarks in the Queen's Park area.

Easily accessible by plane, train, and motor, Toronto is connected with virtually every city in Canada by the Canadian Pacific Railway. Motorists will find the Queen Elizabeth Highway from Buffalo to Toronto one of the best engineered routes on the continent.

Early Registration Urged

To be sure of obtaining reservations at the headquarters hotel—the beautiful and luxurious Royal York—early registration is urged.

ROYAL YORK HOTEL, ULTIMATE IN COMFORT AND LUXURY (upper left photo), is headquarters hotel for Toronto Convention. All legislation for Province of Ontario is enacted in Parliament buildings (lower left view), which have beautiful floral setting. Princes' Gates to Canadian National Exhibition Park are shown in right-hand photo.

Ammended Constitution Is Adopted by Big Majority

OVERWHELMING AFFIRMATION OF the proposal for amendment of the ASCE Constitution is reported by the tellers appointed to canvass the ballot at Society Headquarters on April 19. Of the 12,252 ballots eligible for count, 10,783 were in favor of the proposed change and 1,454 opposed the change. With a two-thirds vote (8,158) required to carry, the proposal was adopted by a margin of 2,625 votes.

As will be recalled, the adopted changes in the Constitution are the work of a Special Committee on Constitution and By-Laws, which was appointed by the Board almost three years ago and assigned the task of preparing a draft of a revised constitution. After extensive work by the committee, headed by former ASCE Vice-President Arthur W. Harrington, a final draft was approved by the Board at its July 1949 meeting and circulated to the Local Sections in August. With receipt of the requisite number of member signatures petitioning the Society to consider adoption of the proposed changes, the proposal was placed before the January 1950 business meeting, which authorized submitting it to the membership for letter ballot.

Salient changes in the newly adopted constitution include shifting the date of the Annual Meeting from January to October and provision for at least three business meetings of the Society annually; a provision to give official Society status to the formation of regional councils of Local Sections; election of Vice-Presidents and Directors by the electorate of their respective Districts and Zones rather than by the entire membership; and elimination for all new members of the provision granting dues exemption after payment for 35 years regardless of age (the provision granting exemption from dues at age 70 is retained). Adopted changes in membership grades include substituting the term "member" for "corporate member" and applying it to all three principal grades of membership; dropping the grade of "Fellow" and changing the designation "Junior" to "Junior Member"; and lowering the minimum age for Associate Members from 27 to 25 years and the maximum age for Junior Members from 35 to 32 years, with provision that the upper age limit for Junior Member veterans may be extended by the Board of Direction whenever necessary. The number of signers required on petitions for future amendments to the Constitution is raised from 75 per Zone to 200 per Zone.

Tellers' Report on Balloting

The tellers appointed to count the ballots on amendment of the Constitution at Society Headquarters April 19, 1950, report as follows:

Total number of ballots received	12,313
Ballots excluded from the canvass	
From members in arrears of dues	27
Without signature	30
Received too late to count	4
Total ballots not canvassed	61
Total ballots canvassed	12,252

Shall the Proposed Amendments to the Constitution as presented in the printed document entitled "Constitution for Ballot, 1950" be adopted?

Yes	10,783
No	1,454
Blank	13
Void	2
Total	12,252
Total votes counted (Yes and No)	12,237
Required to carry	8,158
Carried by	2,625

Tellers were Edward S. Sheiry, chairman, Burr L. Chase, Jr., Francis B. Forbes, Henry Goldfinger, Robert F. Lathlaen, Frederick W. Ockert, Edmund A. Prentis, III, Alan L. Sielke, John H. Stamataky, and Paul M. Wentworth.

ASCE Committee Studies Foreign Employment of Engineers in Federal Service

ASKED BY THE Board of Direction, at its Mexico City meeting last summer, to formulate a Society policy on the employment of engineers in federal service on foreign work, which normally might be performed by engineers in private practice or by a combination of federally employed engineers and engineers in private practice, the ASCE Committee on Public Engineering Practice and Policy has reviewed the Statement of Policy adopted by the Board at its April 1948 meeting and recommended that it be retained for the present.

The Statement of Policy, which was published in the May 1948 issue of CIVIL ENGINEERING (page 59), asserts in part that while,

"The Society recognizes that it is in the interest of the Government of the United States that the best technical information and the best qualified talent in the country be made available to other nations requesting services needed to solve their domestic engineering problems, and that this assistance may require the temporary assignment of properly qualified individual specialists, selected either from government service or private enterprise . . . , [it] does not believe that any Federal Agency should be permitted to prepare engineering designs, plans, specifications for, or engage in supervision of construction of, projects for foreign governments unless the national interest demands such actions. The Society will therefore exert effort to obtain compliance with the above policy in connection with requests from foreign governments for technical services."

Bureau of Reclamation

In addition to recommending retention of the present Statement of Policy, the Committee instructed its chairman to obtain current policy statements on the subject from certain federal bureau heads. The official policy of the Bureau of Reclamation, outlined by Commissioner Michael W. Straus, asserts that, "When such work is in the public interest and cannot readily be performed by private engineers, it is desirable that the Bureau undertake the necessary service if in doing so current reclamation work is not prejudiced." However, it makes clear that, "the Bureau should undertake outside engineering work only within clearly defined limits, determined upon full consideration of the public interest and the rights of private citizens."

The USBR statement continues, "The performance of engineering services not directly connected with reclamation work but otherwise within existing authorizations may be justified when: (1) Services are requested by a Federal agency, which are not conveniently or as economically within the competence or facilities of that agency; (2) a public emergency renders the services of the Bureau essential to the public welfare; (3) a public need occurring under special circumstances of location or time of performance renders the Bureau's assistance an important public service; and (4) a major engineering question arises under such conditions that the confidence enjoyed by the Bureau in respect to competence and impartiality renders its service of unique public value."

Corps of Engineers

Agreement with the ASCE Statement of Policy was expressed by the Department of the Army in a letter from Maj. Gen. Lewis A. Pick, M. ASCE, Chief of Engineers, to ASCE Vice-President Robert B. Brooks, chairman of the Committee on Public Engineering Practice and Policy. Calling the ASCE Statement of

Policy "eminently fair" to both federally employed engineers and those in private practice, General Pick said, "It has been the policy of the Corps of Engineers to conform to the adopted policy of the Society with respect to foreign assignments of engineers, and you may be assured of our continued cooperation."

Bureau of Yards and Docks

A letter from Rear Admiral J. J. Manning, M. ASCE, then chief of the Bureau of Yards and Docks, expressed an essentially similar viewpoint for the Navy Department. He stated that, "As a broad policy, this Bureau limits its engineering activities to such matters as come within the purview of its assigned missions as set forth in the U.S. Navy Regulations 1948, and to such additional engineering work for other agencies of the Department of Defense as may be justified from a military or economic standpoint . . . . In case a request for engineering assistance is submitted by a foreign government, this Bureau will render such assistance only under exceptional circumstances when required by the public interest as determined by the Secretary of Navy in the light of prevailing U.S. foreign policy as enunciated by the Department of State . . . "

Bureau of Public Roads

The policy of the Bureau of Public Roads, set forth in a letter from Acting Commissioner C. D. Curtiss, M. ASCE, "is similar to our policy in federal-aid work—namely, to assist the particular country to organize an adequate highway department and to staff it with local engineers. In other words, in every way to provide the local staff with the advice and information necessary to enable them to do the job themselves and to establish it on a continuing basis." Mr. Curtiss stated the Bureau policy is well illustrated in its three principal current programs in foreign countries—Central America in connection with the Inter-American Highway; rehabilitation of the Philippine road system; and the highway work in Turkey, which is a part of the Greek-Turkish aid program.

Any member desiring a complete copy of the statements quoted here may obtain it from ASCE Headquarters, 33 West 39th Street, New York 18, N. Y.

Per Diem Fees Restrictive

As a corollary to the task assigned the Committee, the question of federal fees to private consulting engineers was considered. Stating that the $50 per diem limit for such fees, as provided in most of the controlling legislation under which federal bureaus can operate, is unduly restrictive, the Committee recommends that the Society sponsor, through EJC, a recommendation that present limitations be sufficiently relaxed in the future to permit federal bureaus without embarrassment to engage competent consulting engineers when necessary.

Members of the Committee on Public Engineering Practice and Policy, in addition to Vice-President Brooks, are Nathan C. Grover and James P. Growdon.

Mrs. G. T. Seabury, Widow of Former Secretary, Dies

ASCE MEMBERS WILL be saddened to hear of the death of Margaret Knight Seabury, in New York City on April 20, at the age of 68. Widow of George T. Seabury, Secretary of the Society from 1925 until his death in 1945, Mrs. Seabury was widely known to the membership through her travels with her husband and in her role of hostess to wives of members attending meetings in New York.

In her own right, Mrs. Seabury was known to the profession through her generous and tireless activities in behalf of the women's section of the Professional Engineers Committee on Unemployment, which functioned during the depression of 1931–1933 to care for the families of unemployed engineers. She played an important part in the formation of the Engineering Woman's Club in 1928. She had been on the Board of Governors, the House Committee, and the Personnel of Membership Committee, and served as president from 1941 to 1943. Through Mrs. Seabury's efforts the club acquired its second, and present, lease at 2 Fifth Avenue, New York.

Mrs. George T. Seabury

Born and married in Providence, R. I., Mrs. Seabury had spent many years of her married life in the Washington Square area of New York and was devoted to neighborhood interests.

Student Chapter Installed at Univ. of Massachusetts

INSTALLATION OF THE 128th ASCE Student Chapter recently took place in Gunness Laboratory at the university, with about 125 present. Until the recent accrediting of the department of civil engineering at the university, the new Chapter had operated as an independent student club.

Principal speaker at the inaugural ceremonies was ASCE Vice-President Albert Haertlein, Gordon McKay Professor of Civil Engineering at Harvard University and head of the civil engineering department in the Harvard Graduate School of Engineering. Professor Haertlein outlined the professional advantages of membership in ASCE and urged his hearers to affiliate as Juniors after graduation. Other ASCE representatives on the program were Don P. Reynolds, assistant to the ASCE Secretary, and Robert H. Dodds, member of the Society's Committee on Student Chapters and associate editor of *Engineering News-Record*. Mr. Dodds discussed the relationship of Student Chapters to the Society.

Richard Homewood, Student Chapter president, was the presiding officer. Prof. Karl Hendrickson will be Faculty Adviser for the group.

New J. Waldo Smith Fellowship Is Available

ANNOUNCEMENT OF THE availability of a new J. Waldo Smith Hydraulic Fellowship to graduate students interested in the advanced study of hydraulics is made by the award committee. A comprehensive investigation of a timely subject in the field of hydraulics or hydraulic engineering is proposed by the committee, which states that the project should be geared to completion within a year with the production of some interesting and useful information. Applications must be in the hands of the chairman, Chilton A. Wright, Polytechnic Institute of Brooklyn, 85 Livingston Street, Brooklyn N.Y., by June 15th, and announcement of the award will be made shortly thereafter.

As in past years, the fellowship will be of joint interest to the graduate student and the institution through which he will work, and the applications will be routed through the institutions themselves. Established by the Society in memory of J. Waldo Smith, former chief engineer of the New York City Board of Water Supply, the fellowship currently carries a stipend of $1,000, plus an allowance for equipment up to $400.

Conditions of administering the fellowship are given in the current 1950 Official Register, recently mailed to all members.

JOSEPH H. EHLERS, M. ASCE
Field Representative, ASCE

THE NATIONAL SCIENCE Foundation legislation (S.247) remains in conference where differences between the Senate and House versions are being ironed out. As reported last month, the House added several amendments which form the basis of differences with the Senate. It is reported that a satisfactory compromise on the security provision added by the House will be worked out soon. Congressman Carl Hinshaw, M. ASCE, is one of the House conferees. Discussions will be resumed after April 19 when the present recess ends.

Army Bill Before House Committee

No report is yet available on the results of the hearings on H.R.5794, the Army Organization bill. There is every reason to believe that the amendments suggested by Engineers Joint Council will be incorporated, and there is a strong probability that the committee will go even further than EJC suggested in protecting the status of specialized engineering units.

Point IV Legislation Undecided

The President's Point IV Program providing for technical assistance to underdeveloped countries is in a state of flux. The situation may have changed considerably by the time this column appears in print.

The House has passed an authorization for the Point IV Program as part of an omnibus foreign-aid bill. The Senate Foreign Relations Committee has reported out another version of such a authorization. The Senate proposal is for the full $45,000,000 recommended by the President for the first year's operations, while in the House bill, the upper limit has been pruned to $25,000,000. The House legislation deals both with the stimulation of private investment in the underdeveloped countries and the furnishing of American technical skill, while the Senate legislation deals only with the furnishing of technical knowledge. Both bills provide for an administrator to be responsible for managing the program. The House legislation provides for a Public Advisory Board. The Senate stipulates a five-year program, and the House sets no time limit. Both bills provide that the various United Nations agencies may be used in achieving the purposes of the legislation. Both bills provide also for bilateral technical-cooperation programs between the United States and individual foreign countries. The dual nature of the program, with operation both by the United Nations and by the United States, will raise many problems of coordination.

Water Policy Task Force Committees

At a recent meeting of the EJC Water Policy Panel, the Coordinating Committee and Task Force Chairmen, final steps were taken in setting up the eight task committees and in scheduling meetings so that reports will be in the hands of the Coordinating Committee by June 1. A Committee on General Economic Principles was also established. This committee will formulate certain basic principles that may prove to be helpful to the Task Force Committees in developing their reports.

Public Works Construction in Alaska

In the Alaska Public Works Program, allotments of about $4,500,000 out of a total authorization of $5,000,000 have been made for construction of local public works in Alaska. A few construction bids have already been called for and construction operations will be in full swing this summer.

Government Reorganization Plans Studied

The Public Works Construction Advisory Committee of the General Services Administration, on which ASCE is represented, has been called upon from time to time to advise the General Services Administrator (and previously by the Federal Works Administrator) on matters relating to public works planning and construction. It recently met to discuss its future field of activities in view of the shifting of engineering organizations under the various reorganization plans. This committee has furnished a good example of successful industry-government cooperation.

Slum Clearance Funds Budgeted

As previously mentioned in this column, the Housing and Home Finance Agency is engaged on a program of Federal Aid Slum Clearance and Urban Redevelopment. Out of a total of $200,000,000 assigned for capital grants during the first two years of the program, somewhat over $120,000,000 had been earmarked as "reservations" for 83 communities up to the middle of April.

Washington, D.C.
April 18, 1950

ASCE Centennial Celebration Committee Is Appointed

AT ITS MEETING in Los Angeles, the Board of Direction confirmed the appointment of a Committee to have charge of the ASCE Centennial, which will celebrate a Century of Engineering in a series of meetings in Chicago, Ill., during the summer of 1952.

Named to the Committee were the following: *Malcolm Pirnie, Chairman; Ralph Budd, Vice-Chairman; *I. V. A. Huie, Vice-Chairman; *Gail A. Hathaway; Enoch R. Needles; Charles W. Bryan, Jr.; *Carlton S. Proctor; *Waldo G. Bowman, Contact Member; William F. Trimble, Jr.; Franklin Thomas; C. Glenn Cappel; *Charles H. Mottier; *Edward A. Dougherty; Louis R. Howson; W. W. De Berard; Howard F. Peckworth; Lenox R. Lohr; A. P. Greensfelder; Samuel A. Greeley; Lester C. Rogers; and Ernest E. Howard, Ex-Officio.

From this Committee the men whose names are starred were appointed to an Executive Committee, with I. V. A. Huie as Chairman.

Report on Subsidence in San Francisco Available

AVAILABILITY OF COPIES of the well-known San Francisco Section report, entitled *Subsidence and the Foundation Problem in San Francisco*, is announced by the Soil Mechanics Committee of the Section, in response to inquiries for an authoritative report on the subsidence problem. Issued by the Subsoil Committee of the Section in 1932, the report is still considered the most comprehensive work to date conducted by the Society on San Francisco subsidence.

Copies, priced at $2, are obtainable from the office of R. D. Dewell, secretary-treasurer of the San Francisco Section, 604 Mission Street, San Francisco 5, Calif.

TOTAL MEMBERSHIP AS OF APRIL 10, 1950

Members	7,539
Associate Members	9,722
Corporate Members	17,261
Honorary Members	39
Juniors	11,066
Affiliates	73
Fellows	1
Total	28,440
(April 9, 1949	25,467)

Back Copies of "Civil Engineering" Requested

READERS WHO HAVE no further use for their October 1949 issues of CIVIL ENGINEERING, which is in short supply, are asked to help some other person who needs a copy by mailing them in to Society Headquarters.

UNESCO Advisory Body Has Meeting in Paris

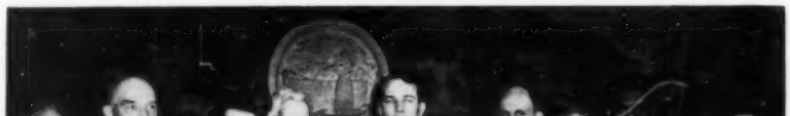
ESTABLISHMENT OF A coordinating federation of engineering organizations formed on a horizontal basis only was advocated by the UNESCO (United Nations Educational, Scientific, and Cultural Organization) Advisory Committee on Engineering Organizations, at a meeting held in Paris, March 6–8.

The Advisory Committee prepared a rough draft of a constitution to be placed before the organization meeting, scheduled to take place in Paris in September 1950, and selected the following list of organizations that will be invited to send delegates to the organization meeting: International Commission on Large Dams of the World Power Conference; International Railways Congress Association; International Commission on Illumination; International Conference on Large Electric Systems; World Power Conference; International Society of Soil Mechanics and Foundation Engineering; International Gas Union; International Federation of Surveyors; International Association for Hydraulic Research; International Conference of Research and Testing Laboratories for Materials and Constructions; Permanent International Association of Navigation Congresses; International Association of Bridge and Structural Engineering; International Institute of Welding; and International Conference on Irrigation.

Organizations that will be invited to be represented by an observer include the International Council of Scientific Unions; International Unions of Pure and Applied Mechanics, Radio, and Chemistry; the International Electric Committee; and the International Standard Association.

The proposed Union of International Engineering Organizations will coordinate the activities of member organizations; avoid overlapping of programs and conflicting dates of congresses; make mutual arrangements for material and moral support; further relations with the United Nations and its specialized agencies; and encourage proposals for the formation of new organizations operating in a field of engineering science not already covered.

As representative of Engineers Joint Council on the United States Committee of UNESCO, Wm. N. Carey, Executive Secretary of ASCE, attended the March meeting of the Advisory Committee in Paris. Present, in addition, were representatives from England, France, India, Netherlands, Sweden, Switzerland, and the United States, together with three members of the UNESCO secretariat.



PHOTOGRAPHED AT RECENT MEETING OF New York University Student Chapter are, left to right, Prof. D. S. Trowbridge, Faculty Adviser; Col. Clarence E. Boesch, Corps of Engineers; Don Reynolds, assistant to Secretary ASCE; Donald Bridgman, with American Telephone & Telegraph; Dean Thorndike Saville; Robert Dodds, associate editor, *Engineering News-Record;* Alfred Glassett, New York consultant; Prof. R. L. Lewis, chairman, civil engineering department; Elmer Timby, member of Howard, Needles, Tammen & Bergendoff; and Eugene D. Jones and Daniel Koffler, Chapter president and vice-president, respectively.

ASCE Members in Mexico Form Local Section

AS A DIRECT result of the friendly relationship established between engineers of Mexico and the United States during the 1949 Summer Convention of the Society in Mexico City, ASCE members living in Mexico have formed a Mexico Section.

Organization plans, which have been under way since the authorization of the Board of Direction was obtained last fall, culminated in a recent gala dinner meeting at the University Club in Mexico City, official meeting place for the new group. The attendance of 28 included an ASCE member from Washington, D.C.—John D. Fitch, chief engineer of the Export-Import Bank—and honor guest Adolfo Orive Alba, secretary of the Ministry of Hydraulic Resources, who will long be remembered for his gracious hospitality by ASCE members attending the Mexico City meeting. New Section officers are Agustin M. Valdes, president; Armando Santacruz, Jr., vice-president; Edward D. Brewster, secretary; and Francisco Gomez-Perez, treasurer. Mr. Valdes was asked to represent the Section at the Spring Meeting in Los Angeles.

Formation of the Mexico Section brings to 70 the roster of ASCE Local Sections.

FRANCISCO GOMEZ-PEREZ, with lighted candle, initiates Section officers at inaugural meeting of Mexico Section. Shown, left to right, are Agustin M. Valdes, Armando Santacruz, Jr., and Edward D. Brewster. Seated, in same order, are Earle S. Sloan, Max W. King, and Frank C. Carey.

Coming Local Section Events

Central Ohio—Joint meeting with the Ohio State University Student Chapter in Pomerene Hall on the campus, May 18, at 6:30 p.m.

Cleveland—Joint dinner meeting with Case Institute of Technology Student Chapter, in Tomlinson Hall, C.I.T., May 19; dinner at 6:30 p.m. and meeting at 8 p.m.

Colorado—Dinner meeting the second Monday of every month at 6:30 p.m.; technical meeting at 8 p.m. Section luncheons every Wednesday at Daniels & Fishers Department Store at 12 noon. The Soil Mechanics and Foundations, Hydraulics, Structural, and Irrigation Divisions of the Section meet monthly on the first Monday, the first Tuesday, the third Thursday, and the fourth Monday, respectively.

Indiana—Joint meeting with Purdue University Student Chapter, in university's Memorial Union Ballroom, West Lafayette, May 19, at 6 p.m.

Kansas—Meeting in Manhattan, May 19.

Maryland—Meeting in the Engineers Club of Baltimore, Baltimore, May 10, at 8 p.m.; preceded by dinner at 7 p.m.

Metropolitan—Meeting in the Engineering Societies Building, New York City, May 17, at 8 p.m.

Mid-South—Spring meeting at the Marion Hotel, Little Rock, Ark., May 19.

Philadelphia—Dinner meeting in the Engineers Club, Philadelphia, June 13, at 6 p.m.

Sacramento—Regular luncheon meetings every Tuesday at the Elks Club, Sacramento, at 12:30 p.m.

San Francisco—Weekly luncheons every Wednesday at the Engineers Club of San Francisco.

West Virginia—There will be a choice of two inspection trips during the afternoon and evening meeting, at Clarksburg, on May 19. Starting at 2 p.m., a group will leave for visit to large-strip mining operation near Clarksburg, and at 3 p.m. another group will tour the Veterans' Administration Hospital now under construction, south of Clarksburg. Dinner at the Country Club will be followed by technical session.

Scheduled ASCE Meetings

ANNUAL CONVENTION
Toronto, Canada, July 12–14
(Board of Direction meets July 10–11)

FALL MEETING
Chicago, Ill., October 11–13
(Board of Direction meets October 9–10)

SPRING CONVENTION
Houston, Tex., February 21–23
(Board of Direction meets February 19–20)

News of Local Sections Briefed

SECTION	DATE	ATTENDANCE	PROGRAM
Akron	Mar. 16	21	Dinner meeting. Albert H. Oldham spoke on the subject, "Famous and Funny Patents."
Buffalo	Mar. 21	59	Dinner meeting with W. P. Creager, Buffalo consultant, speaking on fundamental principles of design of earth dams.
Cleveland	Mar. 24	...	Dinner meeting. William E. Billings, director of transportation and safety, Cleveland Automobile Club, gave a talk on traffic accidents.
Duluth	Feb. 20	20	Revision of ASCE Constitution was discussed. W. R. McEwen, professor of mathematics, University of Minnesota, presented an address on mathematics in engineering.
Florida Gainesville Sub-Section	Mar. 28	...	Joint meeting with the University of Florida Student Chapter. O. W. Irwin, president of the Rail Steel Bar Association, Chicago, Ill., spoke on the current research program of the American Iron and Steel Institute.
Georgia	March	...	Gerald E. Stedman, industrial writer, talked on the engineers place in modern industry.
Illinois	Feb. 6	...	Joint meeting with Western Society of Engineers. Blair Birdsall, assistant chief engineer, John A. Roebling's Sons Co., Trenton, N. J., spoke on "Americanized Prestressed Concrete."
	Feb. 24	61	Symposium on concrete with Henry Miller, Chicago, Ill., consultant, acting as moderator. Speakers included Hal Flodin, Portland Cement Association; H. F. Thomson, the Material Service Corp.; William Ryan, the Consumers Co.; A. S. Holway, Master Builders Co.; George Long, Incland Steel Co.; John Siefried, Ceco Steel Products Co.; and Anton Tedesko, Roberts & Schaefer, consulting engineers of Chicago, Ill.
Iowa	Mar. 29	131	Joint meeting with the Iowa State College Student Chapter, featuring J. O. Jackson, vice-president of engineering and research, Pittsburgh-Des Moines Steel Co., as principal speaker. His subject was supersonic wind tunnels.
Kansas	Mar. 31	50	Dinner meeting. Carlos D. Bullock, regional structural engineer of Portland Cement Association, Kansas City, Mo., gave an illustrated lecture on prestressed concrete.
Kansas City	Mar. 21	...	Symposium on unusual foundation problems in connection with Harlan County Dam project. Speakers included S. C. Happ, K. V. Taylor, R. L. Gillis, and L. G. Teil, all on the staff of the U.S. District Engineer at Kansas City, Mo.
	Mar. 14	56	Juniors meeting with H. K. Shiedler, of Pfuhl & Shiedler, consulting engineers of Kansas City, Mo., discussing fundamental concrete construction practices and their influence on practical design.
Kentucky	Mar. 24	45	Meeting with A. T. Goldbeck, engineering director, National Crushed Stone Association, and Don P. Reynolds, assistant to the ASCE Secretary, as speakers.
Los Angeles	Mar. 8	121	Proposed revision of Constitution was discussed by ASCE Director Julian Hinds. Irving N. Smith, special counsel for the California State Attorney General, presented a speech entitled, "The Tidelands Dispute: States vs. the United States."
Louisiana	Mar. 27	96	Joint meeting with the Tulane University Student Chapter. ASCE Director C. Glenn Cappel discussed the proposed revision of the Society's Constitution. The foundation settlement of Charity Hospital in New Orleans was described by Robert F. Bland, New Orleans consultant.
	Mar. 8	50	Junior Forum meeting. Discussion on collective bargaining.
Metropolitan	Mar. 22	250	Junior Branch meeting with a discussion on "Rubber Railroads"—a new era of revolutionary transportation—led by Paul W. Freitag, Jr., sales engineer of the Industrial Rubber Products Division, Goodyear Tire & Rubber Co., with commentaries by Harold J. Mackin, district sales manager of Goodyear.

	Apr. 12	250	Junior Branch meeting. Waldo G. Bowman, editor, *Engineering News-Record*, presented a talk on saving money on construction.
	Apr. 15	...	Junior Branch inspection trip of construction of United Nations site. I. J. Reading, superintendent of construction at the site for Fuller-Turner-Walsh-Slattery, Inc., guided the tour.
	Apr. 19	250	C. E. Blee, chief engineer, of T.V.A., gave his viewpoint of the T.V.A.'s projects.
Mid-South Jackson Branch	Mar. 29	...	W. L. Heard, assistant state director, Soil Conservation Service, U.S. Department of Agriculture, was the principal speaker of evening.
Montana	Feb. 10	39	Business meeting. Similarities of engineering and forestry were described by Favre Eaton, of the Forestry Service, and two films were shown.
New Mexico	Feb. 10	...	Joint meeting with University of New Mexico. Program conducted by students, featuring David Romer, Bill Fields, and Walter Leffler, as speakers.
Northwestern	Mar. 6	52	W. H. Hart, district engineer, American Institute of Steel Construction, talked on fireproofing for steel.
Philadelphia	Mar. 14	71	Dinner meeting. Symposium on Walnut Lane Bridge was presented by Edwin R. Schofield, associate in the consulting firm of Knappen, Tippetts, Abbett Engineering Co.; Arthur D. Anderson, Springdale, Conn., consultant; and Samuel S. Baxter, assistant chief engineer, Bureau of Engineering, Surveys & Zoning, Philadelphia, Pa.
	Apr. 13	...	Inspection trip to plant of DeLaval Steam Turbine Co. During the dinner meeting, which followed tour, Dr. Miles J. Martin, of the General Electric Research Laboratory, was guest speaker.
Pittsburgh	Mar. 15	25	Juniors' meeting. "Q Floor Construction" was the topic of discussion.
	Mar. 23	69	Joint meeting with the Civil Section of the Engineers' Society of Western Pennsylvania. Papers on airports and airport planning were presented by George Noble, supervisor of airports for Michael Baker, Jr., Inc., consulting engineers, and John B. Sweeney, director of aviation for Allegheny County.
Sacramento	Feb. 7	94	Luncheon meeting featuring Don Thwaits, of the Army Air Force, at Mather Field, Calif., as principal speaker.
	Feb. 21	91	Luncheon meeting with J. N. Bowman, research archivist, Office of the Secretary of State, Washington, D.C., talking on the archives and engineering.
	Feb. 28	124	Luncheon meeting. Francis N. Hveem, with the Testing & Research Laboratory, California Division of Highways, gave a speech on pavement thickness design.
St. Louis	Mar. 27	83	The topic, "Traffic, a Problem in Public Safety and Economy," was discussed by Charles G. Gonter, St. Louis traffic commissioner.
San Diego	Mar. 25	42	Field trip to irrigation and water power developments in the Colorado River area. J. F. Friedkin, with the International Boundary and Water Commission, and Burrage A. Weiss, executive engineer of the Imperial Irrigation District, conducted the tour.
San Francisco	Mar. 21	70	Junior Forum meeting. Robert R. Murdoch, resident engineer on the staff of the East Bay Municipal Utility District, discussed the progress of the $23,000,000 East Bay Sewage Disposal project.
Seattle	Mar. 22	51	Dinner meeting with Dr. Charles E. Miller, assistant director of the Applied Physics Laboratory, University of Washington, as speaker.
Spokane	Mar. 10	...	Business and technical meeting. C. J. Chaffin, Spokane County (Washington) engineer, lectured on the geographic history of the eastern portion of the state.
	Mar. 24	...	P. G. Holgren led a discussion on the proposed revision of the Society's Constitution.
Tacoma	Mar. 14	55	Dinner meeting. C. A. Erdahl, commissioner of public utilities, Tacoma, Wash., described the organization and objectives of the Northwest Power Pool, with discussion by A. R. Haynes.
Toledo	Mar. 1	22	Dinner meeting with several members of University of Toledo Student Chapter as guests. Clayton C. Singleton, regional engineer for the Portland Cement Association, talked on prestressed concrete.

STUDENT CHAPTER *Notes*

NEW YORK UNIVERSITY

"WHAT THE PROFESSION Looks for in the Young Graduate Engineer" was discussed at a recent meeting of the New York University Student Chapter with Dean Thorndike Saville acting as moderator. Participants in the symposium included Col. Clarence E. Boesch, chief, Engineering Division, North Atlantic Division, Corps of Engineers; Alfred T. Glassett, vice-president, W. J. Barney Corp., of New York City; Donald Bridgman, staff assistant, Personnel Relations, American Telephone & Telegraph; and Elmer Timby, member of the New York and Kansas City firm of Howard, Needles, Tammen & Bergendoff. There was an attendance of approximately 130.

UNIVERSITY OF COLORADO

ADVANTAGES OF ENGINEERING registration laws and membership in a professional society were stressed by Frank Prouty, partner in the consulting firm of Prouty Bros. Engineering Co., of Denver, Colo., at a recent meeting of the University of Colorado Student Chapter. Newly elected officers of the Chapter are James I. Billock, president; Gene Goley, vice-president; H. George Marshall, secretary; Charles B. Johnson, assistant secretary; and John S. Houston, treasurer.

UNIVERSITY OF UTAH

MEMBERS OF THE University of Utah Student Chapter took part in the recent engineering day celebrations on the campus. First prize was awarded the Chapter for its interpretation of the theme of four young men progressing through school and becoming world famous shortly after graduation.

ASCE VICE-PRESIDENT Robert B. Brooks, St. Louis, is principal speaker at recent meeting of University of Kentucky Student Chapter. Shown here, left to right, are Prof. A. L. Chambers, Faculty Adviser; Mr. Brooks; Roger L. Hulette, president of Student Chapter; and J. Frank Grimes, president of Kentucky Section.

NEWS BRIEFS

Construction in First Quarter Reaches All-Time Peak

A SUMMARY OF construction activity for the first quarter of 1950 shows new work valued at $4.4 billion, 18 percent above the total for the first quarter of the year and the largest first-quarter total on record, according to a release from the Construction Division of the Department of Commerce and the Department of Labor's Bureau of Labor Statistics. Private construction, during the period, was up 17 percent and public construction 21 percent. Non-farm residential building, valued at $1.9 billion, accounted for about 44 percent of the total for the first quarter, compared with about 35 percent for the first quarter of 1949.

Contributing to this record for the quarter was a seasonal rise in March from the unusually high levels maintained throughout the winter months, with expenditures for the month amounting to $1.5 billion—8 percent above the revised February estimate, and an increase of 18 percent over March 1949. Privately financed new construction work for the month, amounting to $1,125 million, represented an increase of 5 percent over the February estimate and of 18 percent above the total for last March. The value of new residential buildings, exclusive of farm dwellings, was estimated at $620 million—up 5 percent from February and 48 percent above March last year. Though construction of stores and hospitals picked up some during the month, most types of private non-residential building lagged behind a year ago.

Public expenditures for new construction in March, amounting to $375 million, rose 15 percent over the February estimate and 19 percent over the March 1949 total. Though all types of public construction shared in the increase, a seasonal rise of 40 percent in new highway work was primarily responsible for the advance over the February total. Construction of public housing, schools, and hospitals was carried on at rates considerably above those of a year ago.

Construction of New York Thruway Is Authorized

A BILL SETTING up a State Thruway Authority to construct and operate the proposed $500,000,000 Thruway between Buffalo and New York City recently became law with the affixing of Governor Dewey's signature. In signing the bill, Governor Dewey called creation of the Authority "the most important step taken in the way of construction by the state in the twentieth century."

Bertram D. Tallamy

Named to the post of chairman of the three-member Authority, Bertram D. Tallamy, Assoc. M. ASCE, state superintendent of public works, stressed the military advantage of the route that will link most of the industrial and commercial areas of the state.

At its first meeting, the Authority awarded a contract to the New York City engineering firm of Madigan & Hyland for a complete study and report on the Thruway situation. The survey will cover potential traffic, revenues, economic advantages, and construction costs, and will involve allied investigations of traffic conditions on existing highways in the Thruway area. The Thruway is already mapped for most of its course from New York to Buffalo, via Albany, and parts of it have been graded.

Work to Start on Large Boston Department Store

START OF CONSTRUCTION on the second unit of the new Jordan Marsh Department Store in Boston is announced by Thompson-Starrett Co., Inc., general contractors on the project. Second of five units in the Jordan Marsh building program, the new section will be approximately the size of Unit No. 1, which was recently completed by Thompson-Starrett after 16 months of construction. Completion of the present project is expected in the late summer of 1951. Maurice A. Reidy, Jr., Assoc. M. ASCE, Boston consultant, is engineer on the project, and Perry, Shaw & Hepburn are the architects.

Although the new store is being built on the actual site of the present building, business proceeds with a minimum of dislocation under a system of transferring departments from old to new units as soon as they are completed and then tearing down the old units and erecting new structures in their place. With many of the old buildings continuously occupied since the early 1800's, the contractor has serious problems of cross bracing adjoining brick and stone bearing walls. Unstable subsoil conditions throughout the area also increase construction difficulties.

Carlton Proctor to Head Construction Advisory Group

CARLTON S. PROCTOR, M. ASCE, New York City consultant, was elected chairman of the Construction Industry Advisory Council of the U.S. Chamber of Commerce at a recent meeting of the organization in Washington, D.C. A member of the firm of Moran, Proctor, Freeman & Mueser, Mr. Proctor has supervised the design and construction of various important projects here and abroad. He has served ASCE as Director and Vice-President and in many committee assignments.

Carlton S. Proctor

The all-day meeting was devoted to discussion of the construction situation in various parts of the country, urban redevelopment, public works planning, and government reorganization plans. A motion was passed recommending that the Chamber of Commerce oppose Reorganization Plan No. 17, which transfers advance planning to the Housing and Home Finance Agency.

Made up of a number of national trade and professional groups having a major interest in construction, the C.I.A.C. meets annually to consider current developments and problems in the field of construction.

Engineers Urged to Return Data on Their Skills

WITH THE ANNOUNCEMENT that the closing date of the nation-wide survey of selected engineering personnel, sponsored by EJC for the Office of Naval Research, has been advanced to July 15, engineers who have not yet returned their questionnaires are urged to do so at once.

The survey, originally scheduled to close on March 15, is intended to serve as a file of key engineers working in research, development, and other scientific projects who can be called in on a full or part-time basis to work on the scientific programs of the National Military Establishment.

Since only two-thirds of the 115,000 questionnaires that were sent out have been returned, the Office of Naval Research has authorized the mailing of a third reminder to delinquent engineers. Engineers are told that even if they are not now engaged in research or development work, their services may be important to the country because of their special training. ASME is in charge of processing the returns for the ONR.

RECENTLY COMPLETED $27,000,000 HIGH-LEVEL, DOUBLE-DECK BRIDGE across Mystic River at Boston will carry estimated 13,580,000 vehicles in first year, relieving serious north-south traffic problem. With over-all length of more than two miles and with two roadway levels, each accommodating three lanes of traffic, structure is largest steel bridge ever built in New England. Shown here is portion fabricated and erected by Bethlehem Steel Co. Included in Bethlehem section are truss spans over the Little Mystic, sections of the northern and southern approaches, and the toll plaza. Bridge is now open to traffic.

AEC Research Project to Be Located in San Francisco

INITIATION OF A $7,000,000 atomic energy research project, to be located in the San Francisco Bay area, is announced by the Atomic Energy Commission. The project, which will involve construction of a particle accelerator for use in pursuing a classified research program for the AEC, will be undertaken by the California Research and Development Co. in cooperation with the Radiation Laboratory of the University of California.

Through the cooperation of the Navy Department, the project will be conducted at the Livermore Naval Air Station, and preparation of the site for the new work will start soon.

Water Policy Commission Studies Municipal Shortages

THE SEVEN-MEMBER TEMPORARY Water Resources Policy Commission, appointed by President Truman early in January, is studying the question of how far the federal government should go in aiding cities to overcome their water shortages, according to Samuel B. Morris, M. ASCE, member of the commission and general manager and chief engineer of the Los Angeles Department of Water and Power.

Addressing the recent seventh annual convention of the American Public Power Association in Washington, D.C., Mr. Morris said that though many cities in various parts of the country face water-supply problems, "the dramatic circumstance that the largest city in the world is suddenly confronted with a critical water shortage has helped focus attention upon the over-all policy of helping municipalities solve their water-supply problems."

Appointed by President Truman to study and make recommendations to him on existing federal legislation and policies in the water resources field, the commission will submit a report covering various aspects of the national water problem by December 1. Morris L. Cooke, Philadelphia, engineer, is chairman of the commission.

Western Public Officials Have Three-Day Congress

PUBLIC OFFICIALS FROM all over the West pooled their experience and discussed mutual problems at the 1950 Western Public Works Congress in Oakland, Calif., April 2–4. Of special interest to West Coast engineers were panel and round-table discussions on "Air Pollution Problems and Solutions," led by Frank M. Stead, acting executive officer of the State of California Water Pollution Control Board, and "Functions of Public Works Under Disaster Conditions," conducted by W. M. Jarrett, president of the Public Works Officers Department of the League of California Cities.

A M Rawn, M. ASCE, chief engineer and general manager of the Los Angeles County Sanitation District, headed a symposium on the design and functional purposes of special sewer and aqueduct structures. Panel discussers included ASCE members Ben S. Morrow, engineer and general manager of the Portland, Ore., Water Works; R. Robinson Rowe, bridge engineer for the California Division of Highways; Reuben F. Brown, superintendent of the Los Angeles Bureau of Sanitation; Robert F. Lauenstein, design engineer of San Francisco; and Robert C. Kennedy, manager of Special Utility District No. 1, East Bay Municipal Utility District. A panel discussion on the management and operation of city street systems was led by Harmer E. Davis, M. ASCE, director of the Institute of Transportation and Traffic Engineering at the University of California.

An inspection tour of significant public works projects in the Bay area was conducted by B. W. Booker, M. ASCE, district engineer, and R. P. Duffy, district construction engineer of the State of California. Other events on the three-day agenda included a luncheon, addressed by W. O. Jones, M. ASCE, president of the American Public Works Association, and a banquet.

Sponsoring organizations were the American Public Works Association, in cooperation with the League of California Cities and the Institute of Transportation and Traffic Engineering at the University of California.

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MANY PRODUCTS
2. Sand Mix
with Bitumuls
Emulsified Asphalt

An Aleutian transport lands during runway construction. Bitumuls Sand-Mix although only partially cured — supports heavy loads.

"One-man" pavement construction in California with modern mixers. Note Bitumuls non-stop "refueling" from transport.

Florida builds low cost county roads by blade mixing existing sands with Bitumuls.

LOW COST PAVEMENTS from Native Material

Here was an Army Assignment:

"Build 6 big Airports in the Aleutians — in cold, wet weather — and fast. **No** access roads, and sound aggregate not available."

BITUMULS was the **answer.** It mixed easily with the wet existing sand, and cured in record time — Vital factors in repulsing Jap bombers.

Here was a Navy Assignment:

"Pave 1,700,000 sq. yds. of parking area for carrier planes. No local crushed aggregate available. The cost must be **low.**"

BITUMULS was again the answer. Nine Million Gallons stabilized 350 Acres of local sand—6" Deep. Conventional pavement would have required over **600 trainloads** of imported aggregate—at about three times the cost.

State and County Highway Engineers in the "Sandy" South appreciate the stability and low cost of **BITUMULS SAND MIX PAVEMENT.** In the U. S., there are over 25 million sq. yds. of this type of pavement in use. More is being constructed every year—the reasons:

1—Very Low Cost
2—Use of Existing Road Material
3—Ease of Construction
4—Trouble-Free Maintenance

Ask for our BITUMULS BOOKLETS. They are factual, illustrated, and helpful — a valuable addition to your engineering library.

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1,000,000-Gal Storage Tank Built by Prestressing

BIG REDUCTIONS in construction time and costs are claimed by use of new patented Huddleston method of prestressing in erection of 1,000,000-gal water-storage reservoir for City of Monterey Park, Calif. Huddleston method, in use here for first time, provides for even distribution of prestressing in all sections of 48 hoops encircling inner shell of reservoir. In upper photo, workman on left is prestressing hoop to 25,000 psi, and crewman at right prepares to drop wedge behind hoop as soon as hinge-spring calibration on the lever indicates application of proper stress. After completion of prestressing, tank was filled with water and left for 30 days to test for cracks. Prestressing was then checked for uniformity, under water pressure, and adjusted to 22,000 psi in each hoop. Later hoops were covered with protective gunite application, providing outer shell of cement 3½ in. thick. Quinton Engineers, of Los Angeles, designed project, and MacMen Inc., Los Angeles contracting firm, handled construction.

ASTM Committees Initiate New Research

MUCH NEW RESEARCH work was discussed by technical committee members of the American Society for Testing Materials during the recent ASTM Committee Week in Pittsburgh. Almost 1,000 engineers concerned with specifications and tests attended the series of meetings.

Committee C-9 on Concrete and Concrete Aggregates is considering new approaches to measuring the alkali reactivity of aggregates in concrete. The size and pore spaces in concrete aggregates and their relation to durability are under study, and the development of dynamic testing methods for measuring quality of concrete, particularly for field use, is under way. The latter activity will involve use of the sonoscope method. A compilation of the descriptions of the various rock types is also contemplated. Prof. K. B. Woods, M. ASCE, of Purdue University, is chairman of Committee C-9, and Stanton Walker, M. ASCE, director of engineering for the National Sand and Gravel Association, Washington, secretary.

At a meeting of Committee D-4 on Road and Paving Materials, a method of determining the resistance to plastic flow of fine bituminous mixtures by means of the Hubbard-Field Stability Test was proposed for subcommittee action. A proposed new specification to cover a heavy viscosity emulsion for surface treatment is being balloted by the Subcommittee on Emulsified Asphalts. Committee D-8 on Bituminous Waterproofing and Roofing Materials initiated work on performance standards and on the development of standards covering insulating siding materials.

Continuing its work of preparing mechanical testing manuals covering the various fields of steel products, Committee A-1 on Steel will soon issue a manual for bar steels, to be followed later by manuals on tubular products and sheet and strip.

New specifications proposed during the week will receive final consideration at the ASTM annual meeting in Atlantic City during the week of June 26.

Authority to Study N.Y.C. Parking Is Established

FOLLOWING PASSAGE IN the closing session of the New York State Legislature of a bill creating a New York City Parking Authority, the city has awarded a $25,000 contract to the New York firm of Madigan & Hyland to determine the soundness of projected plans for building six public parking garages in Manhattan, the Bronx, Brooklyn, and Jamaica. The firm will also make a general engineering survey of traffic conditions in the city, the study to be financed with federal funds. Estimated cost of the parking garages is $16,000,000.

Last-moment amendments to the Parking Authority Bill, prepared in a conference between city representatives and the State Department of Audit and Control, will bar the Authority from building or operating bus terminals and require it to award to the highest bidder the privilege of selling gasoline, oil, and other supplies, and servicing automobiles in Authority facilities.

Pennsylvania Turnpike Lets Bridge Contracts

THE Pennsylvania Turnpike Commission recently awarded contracts for construction of substructures of two key river bridges in the 67-mile western extension of the Pennsylvania Turnpike to the Ohio state line to the Dravo Corp., Pittsburgh, according to an announcement from the Contracting Division of the organization. Contract prices for both substructures total $1,512,307.

One of the new bridges—a 2,179-ft span and second longest bridge on the entire Turnpike—will cross the Allegheny River near Oakmont, Pa., about 10 miles northeast of Pittsburgh. The other bridge, to be built over the Beaver River, about 30 miles northwest of Pittsburgh, will be 1,540 ft in length.

Opposes Competitive Bidding for Professional Services

ENDORSING RECOMMENDED PROCEDURE of its special Committee on Competitive Bidding for Engineering Services, the Boston Society of Civil Engineers has appropriated funds for publicizing the recommended procedure and is distributing copies of the committee's statement to municipal officials throughout Massachusetts.

Opposing competitive bidding by engineers for public contracts in Massachusetts, the committee states that, "Engineering services are personal services and are professional in their nature, like the services of doctors and lawyers. Engineering services should be employed on the basis of competence, integrity, and mutual confidences between the public authority and the engineer. These conditions may not be fulfilled if the engineering service is selected on a price basis. Competitive price bids lose their significance unless based on precise specifications; and these cannot be written for the intangible qualities of training, experience, ability, judgment and integrity required of the engineering profession.

"Consequently, it is contrary to the best public interest to procure professional engineering services on the basis of competitive prices, as practiced by a few municipalities; because this implies an obligation to employ the low bidder regardless of whether he is best qualified."

A letter from Ralph W. Horne, M. ASCE, who served as chairman of the Committee on Competitive Bidding for Engineering Services, calls attention to the fact that a bill under consideration by the Massachusetts Legislature, will if passed, eliminate competitive bidding by engineers for public contracts.

Improvement of Alaska Harbors Is Recommended

PLANS FOR THE improvement of harbors and rivers in the south-central area of Alaska around Cook Inlet, estimated to cost approximately $50,000,000, have been recommended by the North Pacific division office of the Corps of Engineers, according to an announcement from Col. O. E. Walsh, division engineer. A survey report, authorized by the Flood Control Act of 1948 and prepared by the Alaska district engineer, recommends hydroelectric power developments estimated to cost $45,654,000; navigation improvements totaling $4,400,000; and flood-control work costing $46,000, plus additional sums for annual maintenance in the area.

Cook Inlet basin, and the Anchorage vicinity in particular, are called the hub of the Alaska military defense system.

Human Factor Called Key to Highway Safety

THE HUMAN FACTOR is the great unsolved problem in traffic safety, according to Dr. Clarence C. Little, director of the Roscoe B. Jackson Memorial Laboratory at Bar Harbor, Me. In the principal address at the seventh annual meeting of the National Committee for Traffic Safety, held in Washington, D. C., recently, Dr. Little stated that proper emotional balance is an important factor in preventing highway accidents. Also featured on the two-day program was a panel discussion on specific state and local methods for achieving cooperation among public officials, safety organizations, and support groups.

Representatives of some 85 national organizations from all over the country attended the meeting, which was aimed primarily at enlisting public interest in traffic safety.

Sanitary Engineers Asked to Submit Personnel Data

AS PART OF a comprehensive program of the National Security Resources Board to establish a roster of professional personnel, the American Public Health Association, in cooperation with the Security Resources Committee of the Conference of State Sanitary Engineers, is assembling data on sanitary engineers and their skills.

Stating that a complete list of qualified sanitary and public health engineers is of vital importance to the profession and to national security, the American Public Health Association urges immediate return of the questionnaires that have been sent out. Engineers in the sanitary and public health fields who have not yet received questionnaires should notify the Engineering Section Project of the APHA, 1790 Broadway, New York 19, N.Y.

Netherlands Construction Group Tours United States

A TEN-MAN TEAM representing Netherlands building and construction groups arrived in New York City on March 27 for a six-week inspection tour of construction methods and practices in the United States. The tour is sponsored by the Technical Assistance Division of the Economic Cooperation Administration.

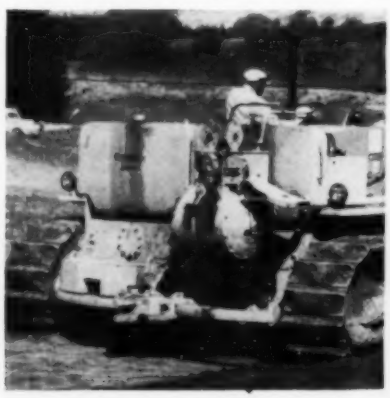
Organizations participating in arranging a program of study for the group include ASCE, the Associated General Contractors of America, the American Institute of Architects, the Washington Building Congress, the National Association of Home Builders, the Building and Construction Trades division of the American Federation of Labor, and the Federal Housing Administration. While in Washington the group met at a round-table conference with representatives of the ASCE, AGC, and AIA.

Ground Is Broken for Whittier-Narrows Dam

BREAKING OF GROUND for start of construction on the $36,000,000 Whittier-Narrows flood control dam in California is announced by the Corps of Engineers. The project, which ends a 15-year local and Congressional controversy, is scheduled for completion in 1955. An earth-fill structure, 56 ft high, the projected dam will close a gap in the lower foothills, known as Whittier-Narrows, through which the channels of the San Gabriel River and the Rio Hondo tributary of the Los Angeles River pass. (See location map in the article by H. E. Hedger in this issue.) Normally dry, these rivers during rainy seasons, carry the runoff from the San Gabriel Mountains and the Sierra Madres, where storms up to an average of over 1 in. an hour for 24 hours have been recorded.

When completed, the proposed dam will prevent damaging floods in a 100-sq mile industrial, agricultural, and residential development in the Long Beach-Whittier area. Construction of the 2,500-acre retarding basin behind the proposed dam will necessitate relocation of two major highways, an oil refinery, a large elementary school, and numerous other installations, in addition to some 500 homes.

"Siamese-Twin" D8 Tractor Provides Double Horsepower Capacity



BY COMBINING two Caterpillar diesel D8 track-type tractors, Buster Peterson of Peterson Tractor & Equipment Co., San Leandro, Calif., has made available 269 hp for less than price of two Caterpillar D8s. Unique arrangement, shown here in front and rear view in use on grading project near San Francisco, was accomplished by removing one track and final drive assembly from each tractor. Special hard bar was then fashioned to permit bolting the two tractors at the final drive housings with large through bolt. Plate was installed on the back of the housings and necessary connections made for controls, which consist of two gear-shift levers, two steering clutch levers, one master clutch lever, and two throttles mounted on left arm rest. Easy transportation is accomplished by bolting skids under each engine and unbolting hard bar and final drive housings.

Outlook for Employment of Civil Engineers Called Good

WHAT ARE THE chances that a new engineering graduate can get an engineering job this year? Next year? In the next few years? Will there be opportunities in spite of competition—is it a growing profession? Which engineering fields command the best salaries?

These and many other related questions are discussed in a report recently released by the U.S. Bureau of Labor Statistics, entitled *Employment Outlook for Engineers*. Published by the Bureau as Bulletin No. 968 in its Occupational Outlook Series, the 119-page study is available from the Government Printing Office, Washington 25, D.C., at 50 cents a copy.

Statistical data assembled between 1946 and 1948 from many reliable sources were carefully analyzed by the Bureau. A large part of the report is based on information from the 1946 Survey of the Economic Status of Engineers made by the Bureau, with the cooperation of the Economic Survey Committee of Engineers Joint Council and the National Roster of Scientific and Specialized Personnel. Prospects are projected, in the light of past and present trends, for the profession as a whole as well as by branches and fields of work.

Noting that engineering is the largest professional occupation for men, that by early 1948 there were a third of a million engineers in the United States, and that opportunities are numerous and should continue numerous in this rapidly growing profession, the report nevertheless warns that "The competition in entering the profession will probably be greater than in many other occupations in the years ahead." It suggests, also, that persons interested in engineering as a career should look into employment possibilities in related occupations.

In the long run, according to the report, engineering job prospects are generally bright for well-trained persons, but there will be stiff competition for the next couple of years, with the situation thereafter approaching a more balanced condition.

As to civil engineers, the demand for their services will continue at a high level for several years and then ease off somewhat, later to resume a slow additional expansion. This forecast is based on the long-range potentiality of a very large construction market, in which civil engineers are highly essential. Caution in prediction is recommended, however, because of the well-known extreme sensitivity of civil engineering to the level of general business activity.

According to the report, almost half the civil engineers engaged in construction, a major field of engineering employment, are in administrative, management or supervisory work, with positions ranging from "that of an official of a large construction firm to that of a site supervisor of a construction gang. Slightly more than a quarter are employed in the general field of design, development, and drafting."

What about salaries? Numerous tables and graphs show actual rates paid in the immediate past, but the most revealing comment is the following on relative rates according to field of work:

"Top salaries in all the major fields of engineering are earned by engineers in administration-management jobs usually attained only after many years of experience.... Jobs in research and sales, as well as administration, generally pay more than such work as inspection, analysis and testing, operation, and college teaching.... Engineers employed by private firms and the federal government have comparable average earnings when length of experience is taken into account. Engineers employed by state and local governments generally have lower earnings."

The report also discusses occupational mobility of engineers, lists many of the important engineering societies, includes an explanation of the registration and certification of engineers, describes the scope and method of the survey, reproduces a large number of tables of data, and concludes with a suggested reading list.

Reclamation Officials Sign Contract Speeding Emergency Construction

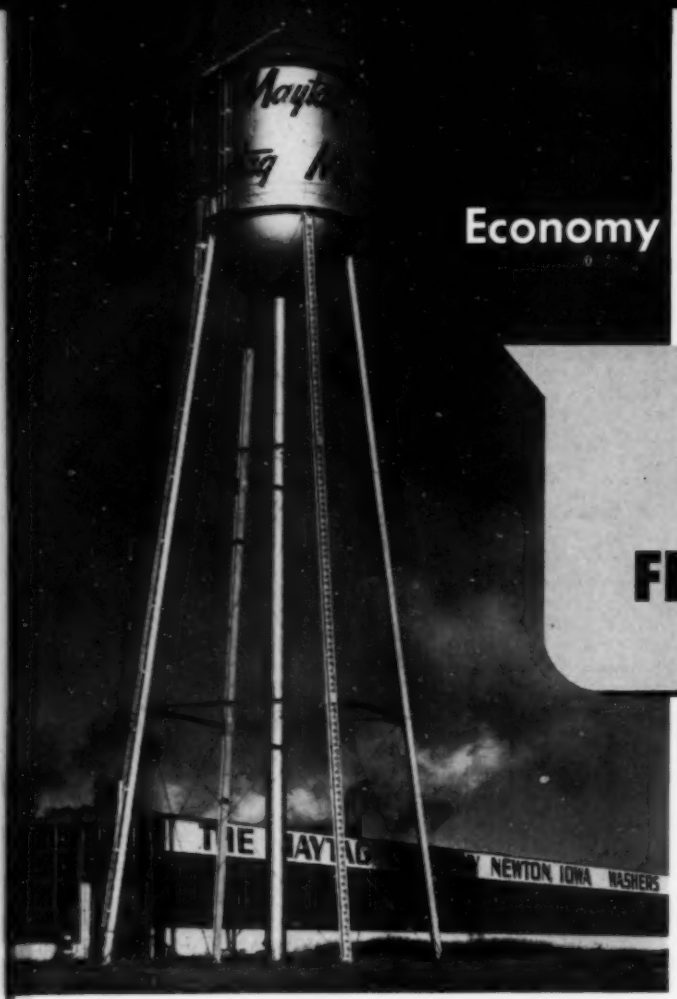
EMERGENCY CONSTRUCTION OF 2,245-FT TUNNEL to supply water to part of Grand Valley reclamation project in western Colorado is launched by signing of Bureau of Reclamation contract. Contract award, following by seven days' collapse of 35-year-old tunnel in Grand Valley project, sets speed record for contract negotiations and will prevent serious crop losses by providing irrigation through bypass tunnel. Affixing his signature to contract is L. N. McClellan, M. ASCE, chief engineer of Bureau of Reclamation. He is flanked by Floyd Shofner, president of Rhoades-Shofner Construction Co. (left), and Everett Seabury, vice-president of Grafe-Callahan Construction Co., joint recipients of contract with bid of $609,800 and offer to complete work in 72 days. Standing, left to right, are Bureau officials, W. E. Blomgren, M. ASCE, assistant chief engineer; W. H. Nalder, M. ASCE, chief designing engineer; and Grant Bloodgood, M. ASCE, chief construction engineer.

Recommends Holding Federal Road Aid at Present Level

CONTINUANCE OF FEDERAL-AID highway authorizations at the annual rate of $500,000,000 was recommended by Public Roads Commissioner Thomas H. MacDonald, Hon. M. ASCE, in recent testimony before the House Committee on Public Works. Mr. MacDonald pointed out that this amount was specifically suggested by President Truman in his budget message, which also recommended that special attention be given to improvement of the interstate system.

The bill now pending in Congress would provide $570,000,000 annually, of which $70,000,000 would be earmarked for the 38,000-mile interstate system, and available to the states on a 75–25 matching ratio. Mr. MacDonald suggested instead that $150,000,000 be set aside for such projects on the traditional 50–50 matching basis.

Reviewing the status of the federal-aid program, Mr. MacDonald reported that most progress has been made on the primary system, with the secondary farm-to-market system a close second. The greatest lag is in improvement of urban arterials, he said.



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R. Robinson Rowe, M. ASCE

"As we grow older," declared Professor Neare, "we are continually learning that the obvious is seldom so. Such a simple thing as $1 + 1 = 2$, for instance, becomes nonsense when our unit is the velocity of light. Joe, did you think of that when you wrestled with Al E. Dayde's problem of the lot for the mile-long-hot-dog stand?"

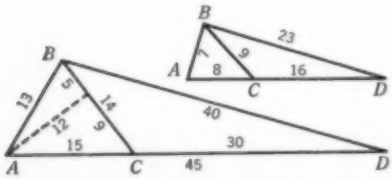


FIG. 1. ONE TRIANGLE plus one triangle equals one triangle.

"Didn't have to," replied Joe Kerr. "The simplest formulas of trigonometry showed me that the 7-8-9 triangle was the original lot with 3 consecutive integers and that the adjoining triangle had to have sides 9, 16 and 23 to satisfy the conditions $BC = BC = 9$, $CD = 2AC = 16$, $P' = 2P = 48$ and $A' = 2A = 24\sqrt{5}$. Obviously the combination will have a perimeter of only 54, so that a hot-dog stand wrapped all the way around the property wouldn't be a mile long."

"Joe didn't read all the hyphens," observed Ken Bridgewater. "A hot dog a mile long could be sold from a shorter stand by coiling it in the oven and selling it from a reel. As a matter of fact, the California mile-long hot-dogs sold at the Los Angeles Convention last month were only 0.00012 mile long; it's just a gag. Besides, for the record, there is another trigonometric solution to the setup—the 13-14-15 triangle adjoined by a 14-30-40 addition."

"That's right," said Cal Klater. "On the face of it, the two solutions make the problem ambiguous, but they have one point in common. In each case the combination of old and new triangles is just one bigger triangle. Like the velocity of light, which Noah hinted about, one triangle plus one triangle equals one triangle, and not a quadrilateral. Al said his client didn't like the shape, so he was unhappy that he still had a triangle."

"Exactly," ejaculated the Professor. "It will be evident from the figure that ACD must be a straight line because BCD with twice the area and twice the base must have the same altitude as ABC. The dotted line shows also that ABC is the geometric sum of the two pythagoreans 5-12-13 and 9-12-15, so that the area is an integer, 84, and that, consequently, all altitudes and trigonometric functions for ABC, BCD and ABD are rational, an uncommon thing for scalene triangles.

"Now for something more serious. Abe, Ben and Cal were killing time in the Chief Engineer's anteroom when they noticed a clean, shiny, brass cuspidor over in the corner and started a penny-pitching contest. Pitching in turn, a pitcher took the contents of the cuspidor whenever his pitch went in. On the average, they succeeded once in 5, 6 and 7 pitches, respectively. If each starts with 50 pennies and makes 210 pitches, how much should each have at the end?"

[Cal Klaters were: the anonymous A Nuther Nutt, Ed C. Holt, Jr., John L. (Stoop) Nagle, Thatchrite (G. C. Thatcher), Ab Stract (Manuel A. Benson), Charles G. Edson, Anne Othernut (J. Charles Rathbun), Parker Piper (Julian Hinds), George B. Richardson, R. E. Philleo, and John Ortheterl (but a second handwriting expert called it John O. Mothball). Also acknowledged is a solution of the canoe problem by Van Masce (J. S. Kendrick).]

Meetings and Conferences

American Institute of Chemical Engineers. Headquarters for the American Institute of Chemical Engineers meeting will be the Statler Hotel, Boston, Mass., June 8–10.

American Institute of Electrical Engineers. The District 5 meeting of the American Institute of Electrical Engineers is to take place at the Hotel Hayes, Jackson, Mich., May 11 and 12.

American Management Association. There will be a meeting of the American Management Association at the Waldorf-Astoria Hotel, New York City, June 1–2.

American Society for Quality Control. The fourth annual convention and fifth midwest conference of the American Society for Quality Control will take place jointly in Milwaukee, Wis., June 1–2.

American Society for Testing Materials. Technical sessions and other events of the 53rd annual meeting of the American Society for Testing Materials will be held in Atlantic City, N.J., beginning the week of June 26. The annual exhibit of testing apparatus and related equipment, and the ASTM biennial photographic exhibit will be held concurrently with the meeting.

American Society of Refrigerating Engineers. The 37th spring meeting of the American Society of Refrigerating Engineers is scheduled for the Hotel Muehlebach, Kansas City, Mo., June 4–7.

American Water Works Association. All technical sessions and exhibits of the 70th annual exposition of the American Water Works Association will be held in Convention Hall, Philadelphia, May 21–26.

Central States Sewage Works Association. The annual conference of the Central States Sewage Works Association is to be held at the Hotel Lincoln, Indianapolis, Ind., June 9 and 10.

Highway Conference. Sponsored by the University of Florida's Department of Civil Engineering, the fourth Annual Highway Conference will be held on the campus at Gainesville, Fla., May 11–12.

Institute of Aeronautical Sciences, Inc. Personal aircraft is to be the theme of the 7th annual meeting of the Institute of Aeronautical Sciences, Inc., at the Lassen Hotel, Wichita, Kans., May 19–20.

Midwestern Conference on Fluid Dynamics. The Midwestern Conference on Fluid Dynamics and the national meeting of the American Physical Society will be held at the University of Illinois, Urbana, on May 12 and 13 instead of May 5 and 6.

Society of Automotive Engineers. The summer meeting of the Society of Automotive Engineers is to take place at the French Lick Springs Hotel, French Lick, Ind., on June 4 through 9.

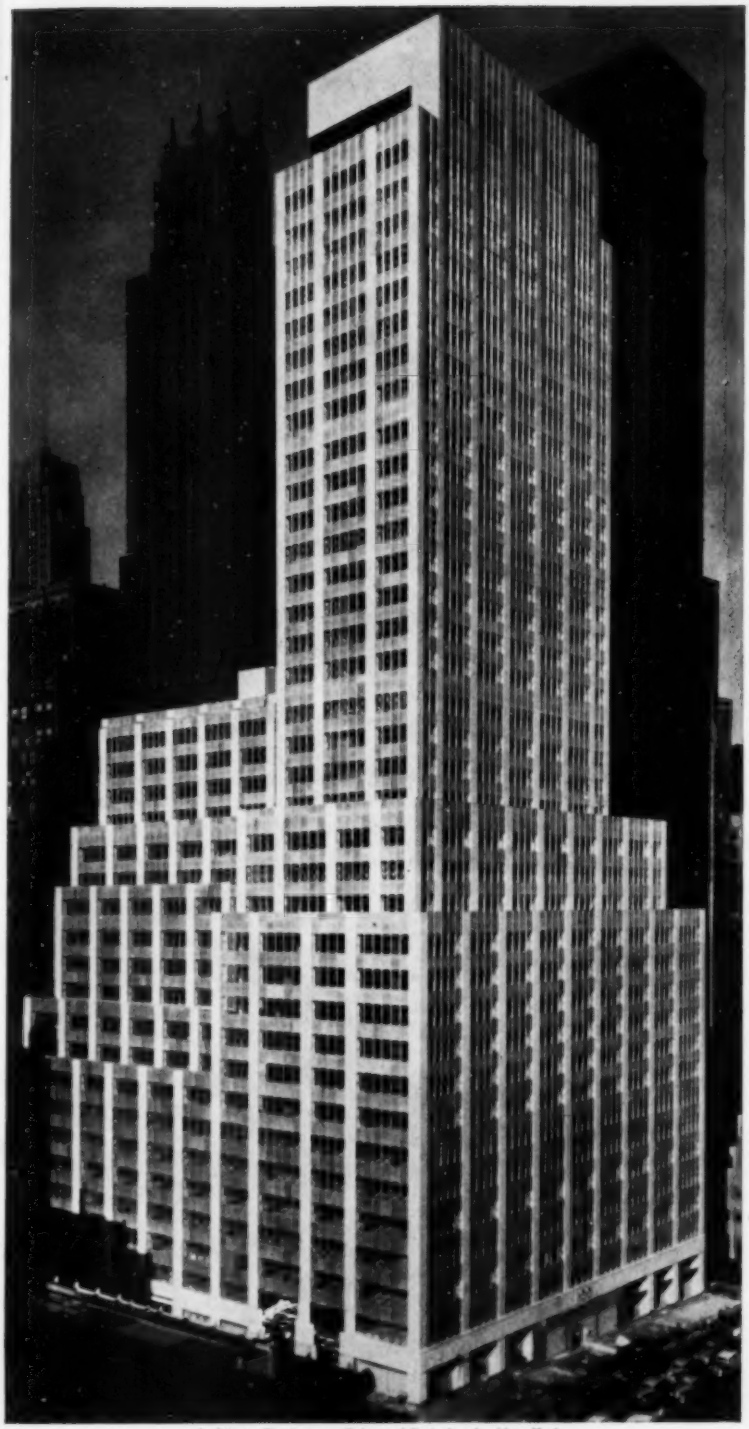
Progress in Ohio River Pollution Control Noted

Only 11 percent of the cities of over 5,000 population in the area affected by the Ohio River Valley Water Sanitation Commission were reported to have taken no action toward the installation of sewage-treatment facilities at the Commission's recent quarterly meeting in Louisville, Ky. Reports from 311 municipalities were presented through the sanitary engineering departments of the eight signatory states.

Despite this "encouraging evidence that the states are aggressively promoting pollution-abatement measures in the basin," according to Joseph L. Quinn, M. ASCE, chairman of the Commission, there are no grounds for complacency. Actually, he said, "only 76 cities have proper treatment works; another 31 have plants, but they are inadequate. And we want to see faster progress on the part of 144 communities that are now preparing plans for construction."

Staff of Chicago Office of ESPS Is Increased

To provide increased engineering placement facilities in the area served by the Chicago office of the Engineering Societies Personnel Service, the organization announces the appointment of Bonnell H. Allen as assistant to Joseph R. Decker, manager of the Chicago office. Mr. Allen is a licensed engineer with a background of a number of years of engineering placement work.



Architects: Ely Jacques Kahn and R. A. Jacobs, New York
Contractor: George A. Fuller Company, New York
Structural Engineer: Fred N. Severud, New York

100 PARK AVENUE

Built for 100 Park Avenue, Inc., this recently completed 39-story office building fronts on Park Avenue, East 40th and East 41st Streets in midtown New York, and stands but a block from Grand Central Terminal, on the site of the famed Murray Hill Hotel.

Known as 100 Park Avenue, the L-shaped, air-conditioned giant contains 660,000 sq ft of rentable floor area. It is serviced by 20 elevators. It has setbacks at the 9th, 11th, 14th, 15th, 17th, and 21st floors, and an 18-story, 70 ft x 130 ft tower. Polished granite is used for its exterior base, and Georgia marble up to the second story level. The remainder of the structure is faced with white brick and aluminum spandrels.

Construction of 100 Park Avenue called for the fabrication and erection of approximately 10,000 tons of steel, all of which was handled by Bethlehem.

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NEW IN Education

THE UNIVERSITY OF Michigan School of Public Health is offering an inservice training course in industrial hygiene and human relations for safety personnel to be held June 19–21, inclusive. Inquiries should be addressed to the School of Public Health Building, Ann Arbor, Mich.

A THREE-DAY NEW England Industrial Wastes Conference, on June 26–28, will be a feature of the 1950 summer session at Massachusetts Institute of Technology. Sponsors are the MIT Department of Civil Engineering, the New England Council, and the New England Sewage Works Association. Professors Rolf Eliassen, Assoc. M. ASCE, and Clair M. Sawyer, represent the MIT sanitary engineering laboratories on the committee in charge of arrangements. According to Professor Eliassen, the Industrial Wastes Conference is designed to bring together three groups—industrialists, government representatives of stream pollution and water control, and research workers and consultants—for discussion of water pollution and control problems.

GRADUATE STUDENTS, TEACHERS, and civic leaders are invited to attend the second annual Institute of Northwest Resources at Oregon State College, Corvallis, June 19–30. Outstanding authorities on northwest resources will present papers on the utilization, conservation, and potentialities of the resources. Field trips will be under the guidance of professional geographers. For information on housing and registration, address Dr. J. Granville Jensen, Professor of Geography, Oregon State College, Corvallis, Ore.

THE 1950 NORTH Carolina Water Works Operators' School will be conducted at the University of North Carolina, Chapel Hill, June 4–9. Sponsored by the N. C. Water Works Operators' Association together with the North Carolina section of the American Water Works Association, the school will be guided by the Institute of Government in cooperation with the School of Public Health of the University. For further information write to Mr. Clifford Pace, Assistant Director, Institute of Government, University of North Carolina, Chapel Hill, N.C.

TO GIVE PRACTICING engineers a thorough knowledge of the various methods of flow measurement, a nine-day course is being offered by the Pennsylvania State College, June 5–15. The syllabus is open to civil, sanitary, mechanical, and municipal engineers, to personnel from engineering schools, state and federal departments, and manufacturers of and companies using equipment involving liquids. For complete information write to Dr. Andre L. Jorissen, Department of Civil Engineering, Pennsylvania State College, State College, Pa.

THE WORLD'S MOST powerful synchrocyclotron, generating 385,000,000 electron volts, is now in operation on a Columbia University site on the Hudson River. This project, which was three years in construction, was developed by the university in cooperation with the Office of Naval Research and the Atomic Energy Commission.

Civil Engineering First Taught at Norwich University

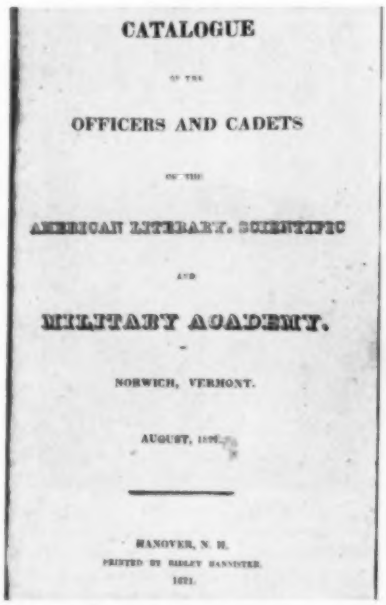
DAVID L. SNADER, M. ASCE
Head, Civil Engineering Department, Norwich University, Northfield, Vt.

NORWICH UNIVERSITY, WHICH has been in continuous existence for 130 years, was the first educational institution in the United States to offer formal organized courses in civil engineering. Though there have been some changes in its name and location, as is true of numerous other well-known colleges and universities, the continuous thread of the institution began with the founding of the American Literary, Scientific and Military Academy by Capt. Alden Partridge in Norwich, Vt., in 1819. Captain Partridge had previously been commandant of the Military Academy at West Point, which may have accounted for his use of the word "Academy."

The accompanying illustrations show photostatic copies of the outside cover page of the first small catalogue issued by the Academy (which became Norwich University in 1834), and of the first page of the catalogue, noting the opening of the institution "at Norwich, in the State of Vermont, on the first Monday of September last (1820)." It will be noted that the catalogue is dated 1821. It should also be noted that the curriculum described on the first page includes courses in surveying and leveling, mechanics, hydrostatics, topography, and "Civil Engineering, including the construction of roads, canals, locks, and bridges."

Records show that some twenty young men, who later became well-known civil engineers, received their early civil engineering training at the Academy during the period 1820–1825. Two of these graduates —Moncure Robinson and Alfred Wingate Craven, both class of 1824—were prominent in the establishment of the ASCE. One of the Committee of Seventeen that met in Franklin Institute, Philadelphia, in April 1839, to discuss the establishment of the Society, Mr. Robinson was also one of the first group of five Honorary Members of ASCE, having been elected in 1853. Mr. Craven presided at the organization meeting of the ASCE, which was held in his office in New York City in November 1852, and later became its President.

Though Norwich University was graduating men in civil engineering in the period 1820 to 1825, Rensselaer Polytechnic Institute, the institution chronologically nearest to it in point of teaching civil engineering, dates its beginning in 1824, with classes starting in 1825, according to its own history (*The History of Rensselaer Polytechnic Institute* by Ricketts). This volume states (page 79) that in its publications "in 1828 is the first appearance of the term civil engineering." This was eight years after the beginning of civil engineering teaching at the Academy, and by then the Academy had an imposing list of civil engineering graduates.



CATALOGUE

OF THE

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OF THE

AMERICAN LITERARY, SCIENTIFIC

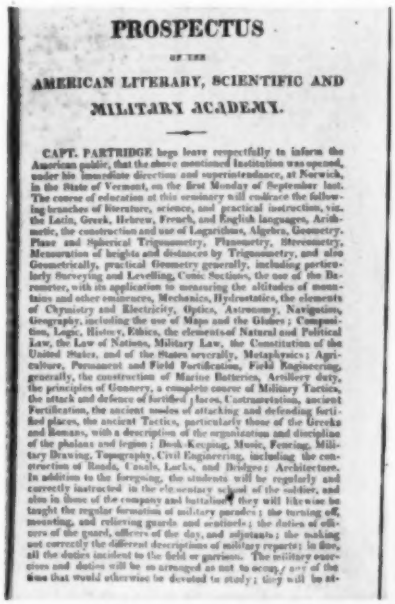
AND

MILITARY ACADEMY.

NORWICH, VERMONT.

AUGUST, 1821.

HANOVER, N. H.
PRINTED BY SIBLEY HANNOTER.
1821.



PROSPECTUS

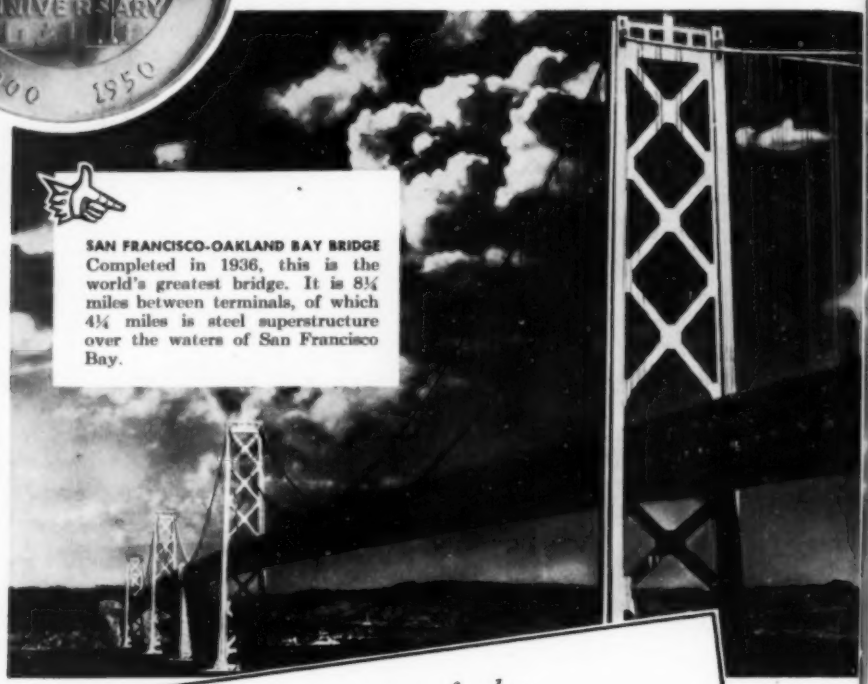
OF THE

AMERICAN LITERARY, SCIENTIFIC AND MILITARY ACADEMY.

CAPT. PARTRIDGE begs leave respectfully to inform the American public, that the above mentioned Institution was opened, under his immediate direction and superintendance, at Norwich, in the State of Vermont, on the first Monday of September last. The course of education at this seminary will embrace the following branches of literature, science, and practical instruction, viz. the Latin, Greek, Hebrew, French, and English languages, Arithmetic, the construction and use of Logarithms, Algebra, Geometry, Plane and Spherical Trigonometry, Planometry, Stereometry, Mensuration of heights and distances by Trigonometry, and also Geometrically, practical Geometry generally, including particularly Surveying and Levelling, Conic Sections, the use of the Barometer, with its application to measuring the altitudes of mountains and other eminences, Mechanics, Hydrostatics, the elements of Chymistry and Electricity, Optics, Astronomy, Navigation, Geography, including the use of Maps and the Globes; Composition, Logic, History, Ethics, the elements of Natural and Political Law, the Law of Nations, Military Law, the Constitution of the United States, and of the States severally, Metaphysics; Agriculture, Permanent and Field Fortification, Field Engineering, generally, the construction of Marine Batteries, Artillery duty, the principles of Gunnery, a complete course of Military Tactics, the attack and defence of fortified places, Countermines, ancient Fortification, the ancient modes of attacking and defending fortified places, the ancient Tactics, particularly those of the Greeks and Romans, with a description of the organization and discipline of the phalanx and legion; Book-Keeping, Music, Fencing, Military Drawing, Topography, Civil Engineering, including the construction of Roads, Canals, Locks, and Bridges; Architecture. In addition to the foregoing, the students will be regularly and correctly instructed in the elementary school of the soldier, and also in those of the company and battalion; they will likewise be taught the regular formation of military parades; the turning off, mounting, and relieving guards and sentinels; the duties of officers of the guard, officers of the day, and adjutants; the making out correctly the different descriptions of military reports; in fine, all the duties incident to the field or garrison. The military exercises and duties will be so arranged as not to occupy any of the time that would otherwise be devoted to study; they will be at-

PHOTOSTATIC COPIES OF 1821 Norwich University Catalogue show (left) first cover page and prospectus of available courses, including civil engineering and allied subjects.

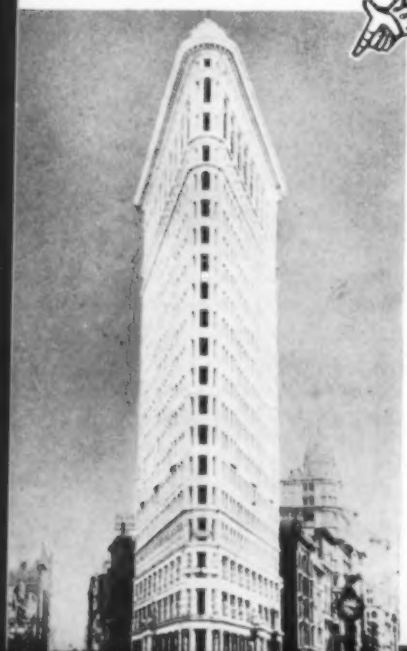
We pause to r



SAN FRANCISCO-OAKLAND BAY BRIDGE Completed in 1936, this is the world's greatest bridge. It is 8¼ miles between terminals, of which 4¼ miles is steel superstructure over the waters of San Francisco Bay.

EMPIRE STATE BUILDING The Empire State Building was fabricated by American Bridge Company in 1930. It is the tallest structure ever built, towering 1250′ above the street level—86 stories topped by a 55′ penthouse section and a 150′ airship mooring mast.

THE FLATIRON BUILDING The Flatiron Building (Fuller) in New York City was fabricated by American Bridge Company in 1901. When completed in 1902, it was perhaps the tallest skyscraper built up to that time.



A representative list of other American Bridge Company structures:

FABRICATED AND ERECTED

Atbara River Bridge
Anglo-Egyptian Sudan, Africa

Blue Water Bridge
St. Clair River, Pt. Huron, Mich.

Bronx-Whitestone Bridge
East River, New York

Carquinez Strait Bridge
Crockett, Calif.

Charter Oak Bridge
Conn. River, Hartford, Conn.

Delaware River Suspension Bridge
Philadelphia, Pa.

Florianopolis Bridge
Santa Catharina Is., Brazil.

Henry Hudson Bridge
New York City

Huey P. Long Bridge
Miss. River, New Orleans, La.

Lake Union Bridge
Seattle, Wash.

Thousand Islands Bridge
St. Lawrence River, N. Y.

Will Rogers Stadium
Broadmoor, Colo.

FABRICATED

Atlantic City Convention Hall
Atlantic City, N. J.

Carew Building
Cincinnati, Ohio

Chicago Post Office
Chicago, Ill.

Chrysler Building
New York City

Cleveland Municipal Stadium
Cleveland, Ohio

Grand Central Station
New York City

Outer Drive Bascule Bridges
Chicago, Ill.

Rockefeller Center—9 Buildings
New York City

Russ Office Building
San Francisco, Calif.

Stevens Hotel
Chicago, Ill.

Wanamaker Stores
Philadelphia & New York

Woolworth Building
New York City

Yankee Stadium
Bronx, New York City

THE HELL GATE BRIDGE Completed in 1917, this bridge, over the East River between Wards Island and Long Island, New York, was the largest arch span ever built up to that time.

to reflect on 50 Busy Years

Come take a glance at just a few of the many jobs we have done over the past half century.

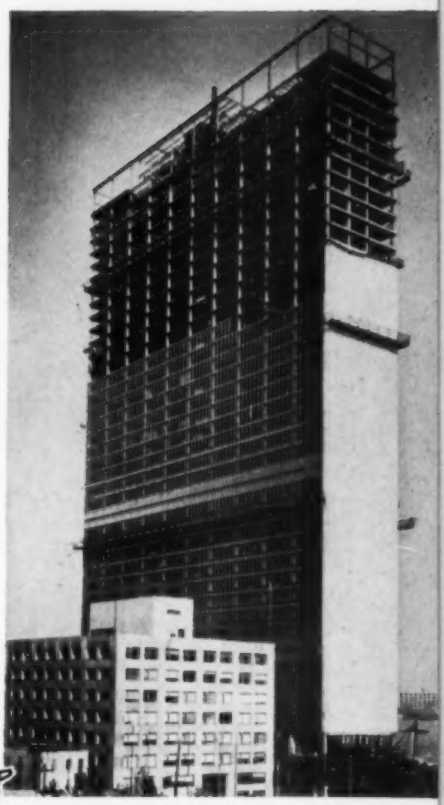
On May 12 the American Bridge Company celebrated its Fiftieth Birthday. But its structural steel experience and know-how are as old as the use of structural steel, and older. For the companies which merged in 1900 to form American Bridge Company brought with them a wealth of experience in the construction of all types of structures.

On these pages are shown but a few of the larger buildings and bridges fabricated, and in many instances, erected by American Bridge Company. Unfortunately space does not permit telling about the thousands of smaller steel structures which comprise a very important part of our Company's operations. For a more comprehensive picture, write for the booklet "Plants and Products—American Bridge Company." It is yours for the asking.

AMERICAN BRIDGE COMPANY

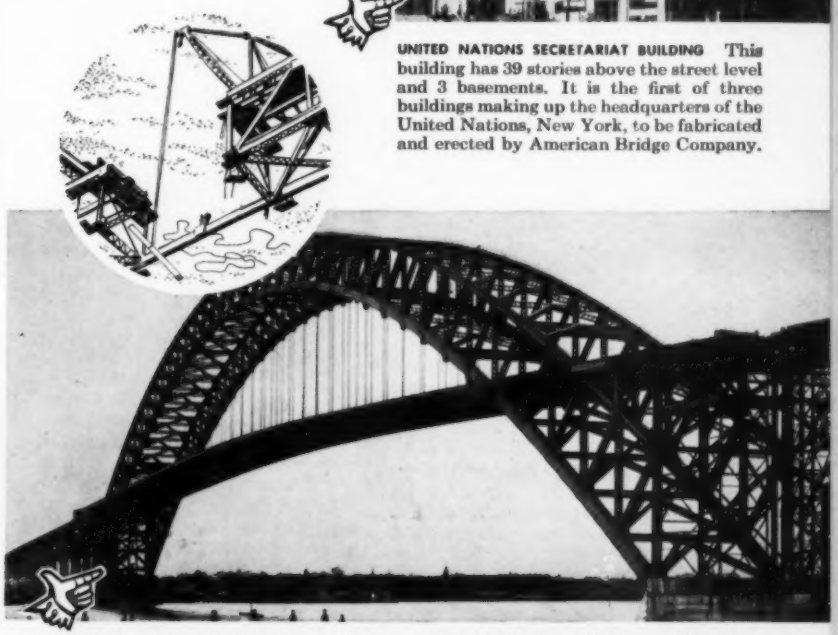
General Offices: Frick Building, Pittsburgh, Pa.

Contracting Offices in: AMBRIDGE · BALTIMORE · BOSTON · CHICAGO · CINCINNATI · CLEVELAND · DENVER
DETROIT · DULUTH · ELMIRA · GARY · MINNEAPOLIS · NEW YORK · PHILADELPHIA
PITTSBURGH · PORTLAND, ORE. · ST. LOUIS · SAN FRANCISCO · TRENTON
UNITED STATES STEEL EXPORT COMPANY, NEW YORK



UNITED NATIONS SECRETARIAT BUILDING This building has 39 stories above the street level and 3 basements. It is the first of three buildings making up the headquarters of the United Nations, New York, to be fabricated and erected by American Bridge Company.

EADS BRIDGE Built in 1868-74 across the Mississippi River at St. Louis, Missouri, it was the first bridge in the United States in which steel was extensively used. The Keystone Bridge Company, one of the companies in the merger to form American Bridge Company in 1900, built this bridge.



THE BAYONNE BRIDGE The Bayonne Bridge, spanning the Kill van Kull, was fabricated and erected by American Bridge Company. It was completed in 1931. This bridge has the longest arch span in the world.

USS **AMERICAN BRIDGE**

Deceased

Albert John Bawden (Assoc. M. '22) for many years assistant engineer for the St. Louis County Highway Department, Duluth, Minn., died on January 9. He was 61. Before becoming connected with the St. Louis County Highway Department in 1911, Mr. Bawden had been with the City of Duluth and the Duluth Water and Light Department. During World War I, he served overseas with the 56th Pioneer Infantry.

Leon Beskin (Assoc. M. '43) assistant chief of research and design in the Bureau of Aeronautics of the Navy Department, died July 9, 1948, according to word just received at Society Headquarters. He was 36 and a graduate of the University of Paris. Before coming to the United States in 1941 he was for six years reinforced concrete and structural steel designer for Entreprise Rouzaud & Fils, Paris.

Philip R. R. Bisschop (Assoc. M. '25) consulting engineer of Johannesburg, Union of South Africa, died on December 23, 1949, at the age of 53. Born in South Africa, Mr. Bisschop was educated at the University of California and did postgraduate work at the Technische Hoogeschool at Delft, Holland. He had been with the Madera Irrigation District and the Pacific Sheet Steel Corp. in California, and later was resident engineer for Van Ryneveld's Pass and consulting irrigation engineer for the African Consolidated Investment Corp., at Johannesburg.

Oscar Charles Blumberg (Assoc. M. '36) senior sanitary engineer, California Department of Public Health, died in Berkeley, Calif., on March 20. He was 46. A graduate of the University of California, class of 1926, Mr. Blumberg received his master's degree in sanitary engineering from Harvard University in 1948, while on leave of absence from the Department of Health. Mr. Blumberg was with the California Water Service from 1928 to 1942, becoming connected with the Department of Public Health in the latter year. He had been active in the American Water Works Association.

Frank Henry Constant (M. '07) professor emeritus of civil engineering and former chairman of the engineering department at Princeton University, died at his home in Princeton on March 16. Dr. Constant, who was 80, retired in 1937 after 23 years on the Princeton faculty. A graduate of the University of Cincinnati, he taught at the University of Minnesota before going to Princeton in 1914. At one time he was vice-president of the American Society for Engineering Education.

Charles William Cubbage (Assoc. M. '24) retired engineer of Baton Rouge, La., died at his home there on March 17. Mr. Cubbage, who was 73, had been building inspector for the New Orleans Housing Authority and general superintendent for the Mobile, Ala., firm of Doullut & Ewin. Earlier he was for some years superintendent of the Kansas City Bridge Co., at Kansas City, Mo.

Edward Smith Cole (M. '13) retired engineer of Upper Montclair, N.J., died at his home there on March 18, at the age of 79. An inventor and hydraulic engineer of note, Mr. Cole retired in 1947 as president of the Pitometer Co., a water survey organization he founded in New York City.

Edward S. Cole

Following his graduation from Cornell University in 1894, Mr. Cole worked for various water survey companies and developed the pitometer method of measuring water velocity. In 1904 he founded the Pitometer Co., and later established branches in London. Mr. Cole was active in the development of an instrument for recording the speed of ships, which was credited by the Navy Department with contributing greatly to the success of ship gunnery, and had written numerous papers on measurement of water and allied subjects.

Paul G. Brown, Former Society Director, Dies

PAUL GOODWIN BROWN, member of ASCE since 1906 and Director from 1924 to 1926, died at his winter home in Palm Beach, Fla., on March 24. He was 79. A specialist in the building of bridges, tunnels, and foundations, Mr. Brown had been in charge of major construction projects all over the country, including Pennsylvania Railroad terminal improvements in Philadelphia and a section of the Broad Street subway there; part of the construction of Grand Central Terminal in New York City; a five-mile tunnel for the Cincinnati Water Works; and the foundations of the Hell Gate Bridge in New York.

Paul G. Brown

As a consultant, Mr. Brown had advised the City of Chicago, the New York City Transit Commission and Board of Water Supply, and many corporations. During the first World War he was supervisor of ship construction for the U.S. Shipping Board and active head of the Military Engineers Committee of Greater New York. At the time of his death he was director and member of the executive committee of Universal Pictures Co., Inc.

Mr. Brown was a member of numerous engineering organizations, in addition to ASCE, and a former president of the Engineers Club in New York City. He was educated at Cornell University.

Sir Ralph Freeman (M. '19) consulting engineer of London, England, died suddenly at his home there on March 11, at the age of 69. After three years at the Central Technical College, Kensington, Mr. Freeman joined the London consulting firm of Sir Douglas Fox and Partners. He was made a partner in 1912 and senior partner in 1921, remaining in active control of the firm (now Freeman, Fox and Partners) to the time of his death. An international authority on steel bridges, Mr. Freeman was in charge of design and construction procedures for the famous Sydney Harbor Bridge, for which he received the Baker Medal of the Institution of Civil Engineers, of five large bridges in Rhodesia, a 3,300-ft suspension span over the Severn, and numerous other structures.

Elbert Brutus Gore (M. '13) of Brownsville, Tex., died on January 19 at the age of 82. Of recent years Mr. Gore had been city engineer of Brownsville, and prior to that he maintained a consulting irrigation practice in Brownsville. Earlier in his career Mr. Gore was consultant for the Hidalgo County (Texas) Drainage District, the Rio Grande Irrigation Co., and similar agencies. He was educated at Ohio University.

James Cottle Hallsted (M. '05) of Pasadena, Calif., died recently at the age of 90. Mr. Hallsted was for many years in private practice—first as member of the firm of Hallsted & McNaugher and its successor firm of Robert W. Hunt & Co., and later as head of his own firm in Chicago. He was a graduate of Rensselaer Polytechnic Institute.

Hans R. F. Helland (M. '28) consulting engineer of San Antonio, Tex., died on March 16, at the age of 59. A graduate of the University of Texas, class of 1911, Mr. Helland was assistant city engineer of Austin from 1912 to 1916, and later city engineer of Paris and Waxahachie, Tex. During World War I, he was a captain in the Corps of Engineers, serving in France. For much of the past 30 years Mr. Helland had been in private practice. As an associate in the firm of Hawley & Freese he aided in the construction of San Antonio's sewerage system, and he recently formed the firm of Helland & Seligman, Ltd., which is currently engaged on a number of civic improvement projects. Mr. Helland was a former president of the Texas Section, and had been prominent in American Legion and Masonic activities.

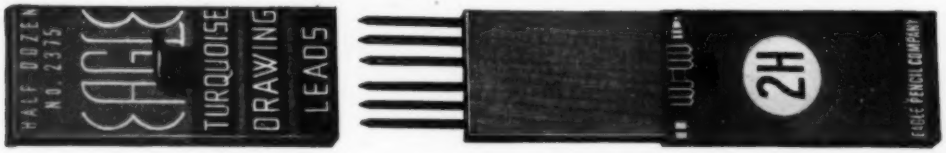
Joseph Stearns Jacoby (M. '49) for the past six months on the staff of the East Bay Municipal Utility District, Oakland, Calif., died suddenly on March 10, at the age of 41. A veteran of World War II, Mr. Jacoby studied at the University of Southern California from 1945 to 1949, receiving both bachelor's and master's degrees in civil engineering. Earlier Mr. Jacoby had been structural draftsman for several New York City organizations, including the Dreier Iron Works, the Leider Structural Steel Co., and Gibbs & Hill.

(*Continued on page 76*)

SEARCHING for the perfect lead holder?

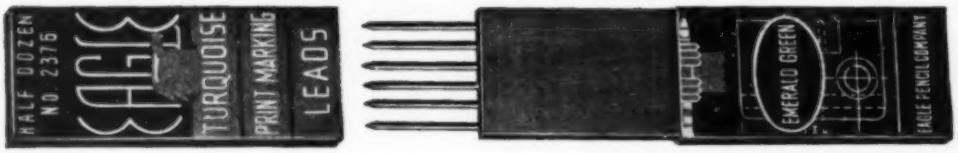
You'll find it in Eagle PRESTOMATIC. Its *rifled* jaws keep a firm, sure grip on the lead . . . never let it push back . . . never bite it off. Non-rolling, featherweight, aluminum barrel makes a permanently beautiful, precision drafting instrument. Handy press-cap quickly controls jaws for lead adjustment. Changeable indicator instantly adaptable to any degree of lead.

SEARCHING for the ideal drawing leads?



Look no further . . . Eagle TURQUOISE Drawing Leads are exactly what you want. They're the same smooth, strong, opaque leads as in famous Eagle TURQUOISE drawing pencils. 15 grades . . . 4B to 9H. Uniform .078" diameter and 5⅛" length.

SEARCHING for colored print-marking leads?



Here they are . . . the same strong, brilliant, *insoluble* leads as in famous Eagle VERITHIN pencils. Vermilion, yellow, white and emerald green for marking blueprints; blue for filling in unwanted white lines; carmine red for marking all black and white prints. PRESTOMATIC lead holders come with a colored cap to match each lead.

EAGLE **TURQUOISE**

Lead Holder . . . **$1**

Leads . . . black or colored . . . **10¢** *each*

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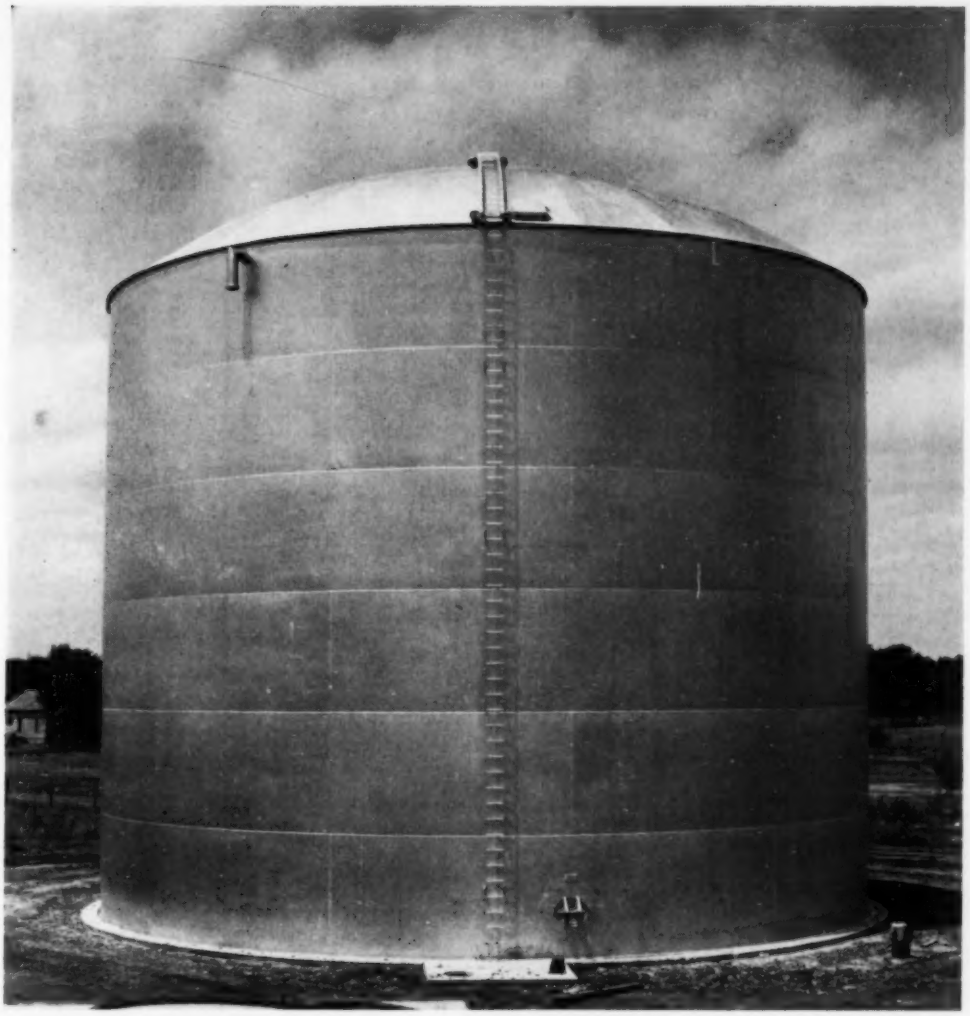


Million Gallon CLEAR WELL for Bartlesville

Frequently, an unusual water service problem is solved when a Horton reservoir is used to provide adequate water storage for a community. At Bartlesville, Oklahoma, the location of the new 4,000,000-gals.-per-day water treatment plant in the flood area of the Caney River makes it impossible to use a conventional design of plant with the clear well underneath the filters. The 1,000,000-gal. Horton steel reservoir shown above has been installed instead, to serve as a clear well.

Now it is possible to supply the distribution system with treated water even during such local emergencies as floods. The highest the flood water has ever been at the tank site was 8 ft. in 1929.

The Bartlesville water distribution system supplies 5,300 consumers. Consumption ranges from 1,000,000 to 2,600,000 gpd.

Horton steel reservoirs provide large-volume water storage facilities for many municipal and industrial water systems. They are widely used because they are economical to construct and easy to maintain. Regular painting keeps the steel in good condition and welded construction assures water-tight joints.

Horton reservoirs are built in capacities up to 10,000,000 gals., while standard capacity Horton elevated tanks range from 5,000 to 3,000,000 gals. We will be glad to supply estimating figures on the cost of a reservoir or elevated tank to consulting engineers or municipal officials without obligation. Write our nearest office stating capacity required, height to bottom, for an elevated tank, and location.

CHICAGO BRIDGE & IRON COMPANY

Atlanta 3.....2167 Healey Bldg.
Birmingham 1.....1596 N. Fiftieth St.
Boston 10.....1009—201 Devonshire St.
Chicago 4.....2199 McCormick Bldg.
Cleveland 15.....2263 Guildhall Bldg.
Detroit 26.....1541 Lafayette Bldg.
Havana.....402 Abreu Bldg.
Houston 2....2128 National Standard Bldg.
Los Angeles 17.1556 General Petroleum Bldg.
New York 6.....3395—165 Broadway Bldg.
Philadelphia 3..1652—1700 Walnut St. Bldg.
Salt Lake City 4....509 West 17th South St.
San Francisco 11..1284—22 Battery St. Bldg.
Seattle 1.....1309 Henry Bldg.
Tulsa 3.....1647 Hunt Bldg.

Plants in BIRMINGHAM, CHICAGO, SALT LAKE CITY and GREENVILLE, PENNA.

(*Continued from page 72*)

Edgar Heisler Lawrence (M. '09) of Washington, D.C., died in a hospital at Takoma Park, Md., on February 7, at the age of 75. A graduate of the University of Pennsylvania, Mr. Lawrence had been architectural engineer for several Chicago firms on the structural design of Chicago skyscrapers. From 1912 to 1918 he was in private practice in Chicago, and later as building specialist for E. I. du Pont de Nemours & Co., at Wilmington, Del. He retired in 1927.

James Otis Letts (Assoc. M. '41) of Rock Island, Ill., died suddenly on March 6 at Ames, Iowa, where he was attending a conference in connection with his work as assistant chief of the hydraulics division of the Rock Island district office of the Corps of Engineers. A graduate of the Missouri School of Mines, class of 1929, Mr. Letts was employed by the Union Electric Co., of St. Louis, before going to the Rock Island district in 1934. He was a veteran of World War II, and a captain in the Reserve Officers Association.

Lewis Earl Mathews (Jun. '45) since 1946 draftsman and designer for Webber & Co., Los Angeles, Calif., died suddenly on November 5, 1949, according to word just received at Society Headquarters. He was 29 and a graduate of the University of Colorado, class of 1945. During the war, Mr. Mathews served as an instructor in indoctrination courses for draftsmen at the Consolidated Vultee Aircraft Corp., San Diego.

Carl Lowell Randolph (Assoc. M. '28) who recently retired from the Hydrology Division of the Los Angeles County Flood Control District, died recently at his home at Arcadia, Calif., at the age of 62. Mr. Randolph had been a resident of Arcadia since 1924, and for the past 18 years had served on the Los Angeles County staff.

Ralph Whitney Reynolds (Assoc. M. '20) superintendent of the West Palm Beach Water Co., West Palm Beach, Fla., died in a hospital there on March 22, at the age of 63. A graduate of the University of California, Mr. Reynolds was Eastern manager of the Pacific Tank & Pipe Co. in New York from 1920 to 1926. He then became superintendent of the West Palm Beach Water Co. From 1940 to 1942, he served on the board of the American Water Works Association.

Past Director Frank T. Darrow Is Dead

FRANK TENNEY DARROW, retired chief engineer for the Burlington Lines and former Director of the Society, died at Riverside, Calif., on February 27. Mr. Darrow, who was 74, spent practically his entire career with the Chicago, Burlington & Quincy Lines and its predecessor, the Burlington & Missouri. From 1908 to 1937 he was assistant chief engineer at Lincoln, and from 1937 to 1939 chief engineer at Chicago. From the latter year until his retirement in 1943 he was chief engineer of the Burlington Lines, which includes the Chicago, Burlington & Quincy and its affiliated lines.

Frank T. Darrow

A full member of ASCE since 1909, Mr. Darrow served as Director from 1921 to 1923. He also belonged to the American Railway Engineering Association, the Western Society of Engineers, and the Western Railway Club. A graduate of Allegheny College, he was a member of Sigma Tau and author of several papers on railroad engineering subjects.

Clarence Samuel Rowe (M. '21) of Chicago, Ill., died over a year ago, though word of his passing has just reached the Society. Mr. Rowe, who was 77, had spent most of his career in the service of the City of Chicago. From 1906 until his retirement a few years ago he was engineer of bridge construction for the city.

Harold Clair Stowe (M. '10) retired engineer of Lebanon, N.J., died on February 14, at the age of 82. While in the employ of several New York firms and later (1910 to 1918) as head of his own construction firm in New York, Mr. Stowe built a number of public schools for the New York City Board of Education. Retiring in 1922, Mr. Stowe had since devoted himself to farming, conducting some experiments in crop cultivation in cooperation with the New Jersey State College of Agriculture.

John Malcolm Waller (Assoc. M. '17) of Kansas City, Mo., died on November 30, 1949, according to word just received. He was 63. From 1907 to 1911 and from 1923 until his death, Mr. Waller was associated with the Kansas City Structural Steel Co. as designer of structural steel for various bridge, building, and smelter works projects. In the intervening period he was connected with the Kansas City Terminal Railway Co., on the construction of the present Union Station; the Bureau of Railway Valuation of the Interstate Commerce Commission; and the Valuation Department of the Missouri, Kansas & Texas Railway.

Harry Esmond Warrington (M. '07) retired engineer of Los Angeles, Calif., died at his home there on February 21, at the age of 81. A graduate of the University of Cincinnati, class of 1890, Mr. Warrington spent his early career in railroad work. Later he was with the California Highway Commission and, prior to his retirement in 1947, he was for some years engineer for the Los Angeles County Sanitation Districts.

NEWS OF Engineers

Robert T. Colburn, engineer of Boston, Mass., has been made a member of the firm of Chas. T. Main, Inc., of that city.

Col. John H. Carruth, who has been in government service for more than 35 years—recently as commander, Engineer Supply Section, San Antonio, Tex., general depot—has retired from the Army. After a summer tour of Europe, Colonel Carruth plans to become affiliated with the Federal Services Finance Corp.

J. L. Faisant announces the formation of the firm of J. L. Faisant & Associates, consulting engineers, of Baltimore, Md. His associates are **A. R. Wiggins** and **B. A. Wiggins.**

Presidental reappointment of the six non-government members of the 11-man Water Pollution Control Advisory Board is announced by Federal Security Administrator Oscar R. Ewing. The appointees include ASCE members **T. A. Berrigan,** chairman of the Merrimack Valley Joint Sewerage Board, Boston, Mass.; **Michael Klein,** chief engineer, Office of the President, Borough of Manhattan; and **N. T. Veatch,** of the Kansas City, Mo., consulting engineering firm of Black & Veatch. Chairman of the Board is **Mark D. Hollis,** M. ASCE, assistant surgeon general and chief of engineering activities, Public Health Service.

J. W. B. Blackman, Garden Grove, Calif., consultant, has gone to Europe, where he will inspect engineering works. Mr. Blackman has been engaged on the design of the Deep Water Port at Sacramento, in association with **George F. Nicholson,** for the Sacramento-Yolo Port District.

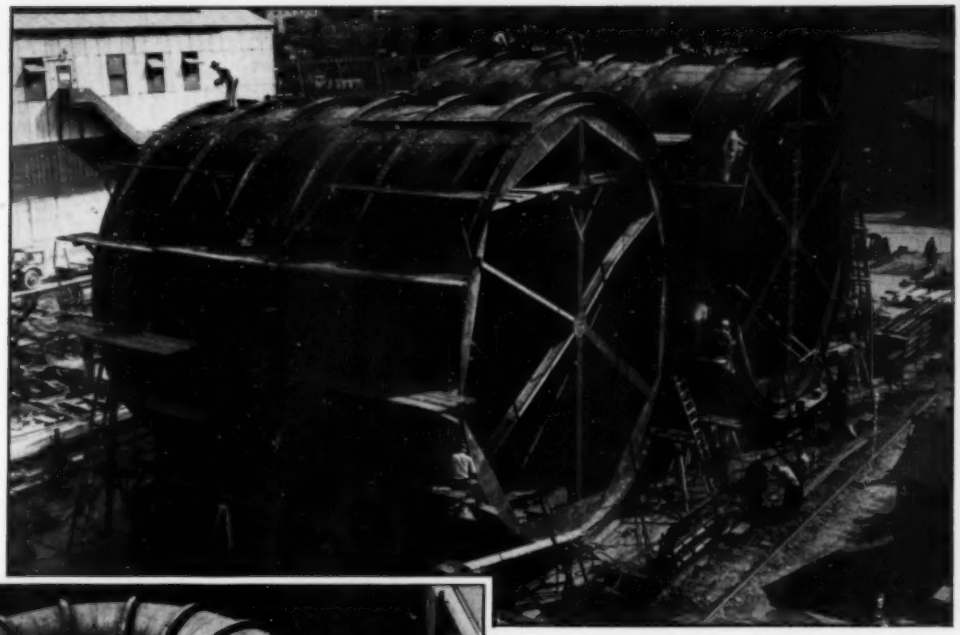
Milton P. Kitchel has been made chief building inspector for the City of Oakland, Calif.

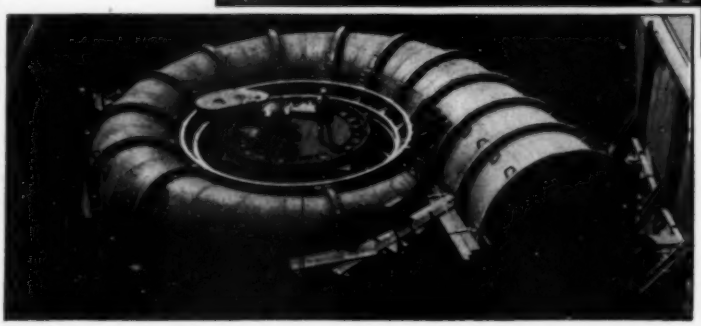
Carl A. Trexel, rear admiral, CEC, USN has retired after 33 years of service. He has accepted the position as executive manager of the International Marine Platform Constructors, of San Francisco, Calif.—a joint venture organized by Ben C. Gerwick, Inc., San Francisco, and Stolte, Inc., Oakland. During the war Admiral Trexel served with the Bureau of Yards and Docks in Washington, D.C., and as director of the Alaska Division.

Carl A. Trexel

L. J. Sverdrup and **W. W. Horner,** of St. Louis, Mo., have been appointed to an engineering advisory committee of the Atomic Energy Commission, and will recommend plans for the development of the reactor testing station at Arco, Idaho.

(*Continued on page 78*)





TO HARNESS THE ELEMENTS

Shown are shop erections of sections of a wind tunnel and a water turbine spiral casing at Newport News. One to be used in the development of America's planes of the future, the other to generate power in the world's largest hydro-electric development.

Tolerances required for the 34-foot diameter welded structure of the wind tunnel were: flushness or smoothness plus or minus 0.01″; fairness of structure 0.03″ and up to $^{1}/_{32}$″ in diameter.

Eighteen of the 165,000 horsepower turbines at Grand Coulee have been built by Newport News. Nine sections of the casings are cast steel and six are welded and cast. These turbine units are the most powerful ever built.

Refractory towers, pressure vessels, bridge caissons and other heavy equipment of special design are fabricated at Newport News. The plant, over a mile in length, includes welding and steel fabricating shops, machine shops, foundries and forge shop to provide the advantages of building the complete job.

"Facilities and Products" catalog will be sent if requested.

NEWPORT NEWS

SHIPBUILDING AND DRY DOCK CO.

NEWPORT NEWS, VIRGINIA

(*Continued from page 76*)

Howard, Needles, Tammen & Bergendoff, consulting engineers of Kansas City, Mo., and New York, announce the retirement to inactive status of **Henry C. Tammen,** of the New York Office, and the admission as partners of **Theodore J. Cambern, James P. Exum, Ellis E. Paul, Joseph Sorkin,** and **Elmer K. Timby.**

S. A. Kerr is retiring from the position of regional planning engineer with the U.S. Bureau of Reclamation at Sacramento, Calif. Mr. Kerr plans to spend the summer at Titusville, Pa.

Edward L. Moreland, since 1946 executive vice-president of the Massachusetts Institute of Technology, will retire in July. Dr. Moreland served as head of the electrical engineering department from 1935–1938 and as dean of engineering from 1938–1946. He has been a member of the firm of Jackson & Moreland since 1919.

William R. Osgood, formerly with the Navy Department at the David Taylor Model Basin, Washington, D.C., has become connected with the Armour Research Foundation of the Illinois Institute of Technology, as a research engineer. An authority on the behavior of engineering materials, Dr. Osgood served as a materials engineer for the National Bureau of Standards from 1929 to 1946.

Brehon Somervell, president of the Koppers Co., Inc., for the past four years, was elected chairman of the organization's board of directors during the annual meeting recently.

E. E. Foster, of the Branch of Project Planning, U.S. Bureau of Reclamation, Denver, Colo., has been loaned for a three-month period to the Department of Army, Far Eastern Command, to serve as consultant on irrigation and drainage for land reclamation of the Ryukyu Islands.

W. B. Wendt, professor of civl engineering in the Speed Scientific School at the University of Louisville, Ky., will retire in July after 25 years as head of the civil engineering department. Professor Wendt founded Theta Tau and Sigma Tau engineering fraternities and the ASCE Student Chapter at the university.

Lt. Gen. Eugene Reybold, wartime Chief of Engineers, has been appointed to the post of executive vice-president of the American Road Builders' Association, Washington, D.C., succeeding Charles M. Upham, who retired recently after 24 years of service. In the Corps of Engineers from 1908 until his retirement in 1946, General Reybold served as district engineer at Buffalo, N.Y., in charge of river and harbor work; and in similar capacities at Wilmington, N.C., Memphis, Tenn., and in the Philippines. Awarded the Distinguished Service Medal in World War I, he achieved similar recognition in the form of an Oak Leaf Cluster in World War II.

General Reybold

S. D. Caplan has opened an engineering office in the Continental Bank Building, Kearns, Utah, where he will specialize in water supply, municipal engineering, and construction materials testing throughout the intermountain area. A. Miller Sams will be associated with Mr. Caplan under the firm name of Engineering Services.

Walter H. Frick announces the reestablishment of his office as consulting architectural engineer, with headquarters at 950 Century Building, Pittsburgh, Pa. Colonel Frick recently concluded an active tour of military service.

N. B. Garver, for the past 30 years bridge engineer for the Arkansas Highway Department, has retired from active duty. He will be connected with the department in the capacity of part-time consultant. **Ward Goodman,** who has been assistant bridge engineer, will succeed Mr. Garver.

A. D. Hutchison, of Greenville, Tex., has been promoted to assistant district engineer of District 1 of the Texas Highway Department, at Paris. During the Second World War Mr. Hutchison served as a major in the Corps of Engineers.

L. Vaughn Downs, previously Bureau of Reclamation engineer at Coulee Dam, has been transferred to the new post of chief of the field engineering subdivision of the Columbia Basin Project's Irrigation Division, at Ephrata, Wash. In this capacity, Mr. Downs will be responsible for the location of lateral canals and the layout of farm units in connection with the irrigation of the area beginning in 1952. Mr. Downs became affiliated with the Bureau of Reclamation upon his graduation from the University of Kansas in 1931.

L. Vaughn Downs

Lt. Col. Herbert C. Gee, since 1947 assistant chief of Civil Works in charge of the nationwide flood control program, has announced his resignation from the Army. Colonel Gee expects to establish a consulting office in West Palm Beach, Fla.

Henry Rich recently retired as head engineer of the U.S. Engineer office at Sacramento, Calif.

Thorist Murphy, of the U.S. Geological Survey, has been promoted to the position of district engineer. He will supervise mapping projects in Washington and Oregon.

George K. Leonard is now chief construction engineer for the Tennessee Valley Authority at Knoxville, Tenn. Through an error confusing Mr. Leonard with **George P. Leonard,** Assoc. M. ASCE, it was inadvertently stated, in the March issue, that Mr. Leonard was connected with the Minneapolis Dredging Co., and the Martin Wunderlich Co., before going to the TVA. **W. K. Seaman** will succeed Mr. Leonard as project manager of the South Holston and Watauga projects, and **H. L. Broadfoot** will have charge of generating installations at Chickamauga and Guntersville dams.

Frank P. Fifer, engineer consultant to the division engineer, North Atlantic Division of the Corps of Engineers, New York City, has retired after 25 years of service. Mr. Fifer plans to engage in consulting work at Annapolis, Md. During his career with the Engineer Corps, his assignments included work on the development of the flood control programs on the Merrimac and Susquehanna river basins, the Passamaquoddy tidal power project, and many others. Noted for his study of the St. Lawrence River Seaway, he is the author of numerous articles on the subject, one of which appeared in the November 1949 issue of CIVIL ENGINEERING.

Frank P. Fifer

John C. Page, retired commissioner (1937–1943) and consulting engineer (1943–1947) of the Bureau of Reclamation, is the recipient of the Department of Interior's highest honor, the Distinguished Service Award. **L. N. McClellan,** M. ASCE, and chief engineer for the Bureau, at Denver, Colo., presented the gold medal to Mr. Page and cited him for his 36 years of service on the Grand Valley and Boulder Canyon projects.

A major reorganization of the water system divisions of the Los Angeles Department of Water and Power became effective recently. One of the principal changes involves the consolidation of the Water Construction Division with the Field Engineering Division. **Norman M. Imbertson** has been named senior water works engineer in charge of the Construction and Inspection Division, and **Sterling S. Green,** senior water works engineer to head the design and laboratory section.

Don C. Davis, formerly a member of Quinton Engineers, Ltd., Los Angeles, Calif., has become city engineer of Banning, Calif.

Kenneth G. Tower, for the past ten years hydraulic engineer with the Portland, Ore., District of the Corps of Engineers, has become chief of the Power Division of the United Western Investigation of the U. S. Bureau of Reclamation, at Salt Lake City, Utah. The primary objective of the Bureau investigation is to get water to Los Angeles—one suggestion is taking water from the Columbia River to California.

M. P. O'Brien, head of the department of engineering at the University of California, has been appointed chairman of the newly created Air Pollution Committee of the San Francisco Bay Area Council.

F. C. Eberhardt is chief engineer for the Morrison-Knudsen Co., Inc., on construction of the $10,000,000 Kortes Dam, 60 miles southwest of Casper, Wyo., a Bureau of Reclamation project.

Harry R. Witt, of the Civil Engineer Corps of the Navy, at Lynnhaven, Va., has been transferred to Seattle, Wash., headquarters.

(*Continued on page 82*)

Engineering Societies PERSONNEL SERVICE, INC.

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Men Available

CIVIL ENGINEER; Jun. ASCE; 27; single; B.S. degree; receiving master's degree from Harvard Business School, June 1950; 5 years' field and office experience in contracting. Knows French, German, Dutch. Desires position preferably in smaller city in northeast in which business administration training will be asset, or in teaching. C-584.

CIVIL ENGINEER; Jun. ASCE; graduate; 32; registered professional engineer. Now resident engineer on new generating station construction for large Midwest utility. Widely varied construction and administrative experience. Desires opportunity in engineering or administrative work with greater opportunity for advancement. Desires Chicago location. C-585.

CIVIL, HYDRAULIC AND HYDROELECTRIC ENGINEER; Assoc. M. ASCE; 31; 4 years with U.S.E.D. as hydraulic and hydrographic engineer; 5 years with consulting firm as assistant project engineer on hydraulic, hydroelectric, and civil engineering projects including 6-month period in Israel on port development and water supply work; available immediately. C-586.

CIVIL ENGINEER; Jun. ASCE; 24; married; veteran; B.S. in C.E., candidate for M.S. in soil mechanics, June 1950, Purdue University; summer experience in soil testing. Desires position in foundations, soils or structures; will consider any location. C-587.

CIVIL ENGINEER; Assoc. M. ASCE; 35; married; registered civil engineer; 15 years' progressive experience in positions as structural and civil engineer on highways and large concrete construction of copper plants, air bases, barges, and aqueducts. Available immediately. C-588-499-A-2.

CIVIL ENGINEER; Jun. ASCE; 29; instructor; primary interest additional experience in construction or design. Registered professional engineer with M.S.; 3 years' teaching civil engineering; 3 years' structural design and drafting for paper mill; a year U.S.G.S. Prefers northern U.S. Available June 15–September 15, but will consider permanent position if good opportunity. C-590.

CIVIL ENGINEER; Jun. ASCE; B.S. in C.E.; completing work on M.S. in structural engineering; Tau Beta Pi; 23; married; a year's experience in field construction; 3 years' experience in survey work. Desires work in structural design or soils and foundation studies. Available in June. Prefers to locate in Midwest. C-591.

CIVIL ENGINEER; Jun. ASCE; 23; single; B.S., Oregon State College, 1949; 1½ years' general engineering experience. Desires employment with established construction firm. Prefers Western location. C-592.

CIVIL ENGINEER; Jun. ASCE; 33; married; M.S., June 1950; veteran. Class B operators license from the Florida Water and Sewage Operators Association; 15 months' experience in sewage treatment plant, structural engineering, administrative or sales engineering. Salary, $4,500 a year. Location optional; available on short notice. C-593.

GRADUATE CIVIL ENGINEER; Assoc. M. ASCE; married; 12 years' top-level experience in planning, design, preparation of specifications, estimating and supervising construction roads, storm drainage systems, water supply and distribution systems, sewerage systems, airfields, and miscellaneous structures; 2 years' employment on Guam and a year in Japan. Presently, technical adviser for Air Forces in Far East. Capable, qualified administrator. Available domestic or foreign assignment, August 1950. C-594.

CIVIL, STRUCTURAL ENGINEER; M. ASCE; licensed professional engineer in Virginia, Georgia; B.S. in C.E.; L.L.B.; 52; married; 2 children; 25 years' broad and comprehensive experience; 8 years' in structural design of important structures and 7 years' responsible administration of engineering and construction contracts; desires position as structural designer, administrator, assistant administrator, or technical adviser. C-595.

CIVIL ENGINEER; Jun. ASCE; 25; single; graduate Villanova College, 1945, civil engineering; 4½ years' experience varied construction; construction superintendent large chain stores; South American oil refinery; assistant superintendent on housing and apartments. Desires field work, preferably foreign or with travel. Available immediately. C-596.

ASSISTANT CHIEF PLANNING ENGINEER, ASSISTANT CHIEF DESIGN ENGINEER; Assoc. M. ASCE; 49; married; B.S. in C.E. and irrigation; registered C.E.; 16 years' experience planning, layouts, design, and detailing of irrigation, drainage, flood control and hydroelectric power projects. Desires employment foreign countries only. Available immediately. C-597-4811-A-7.

CONSTRUCTION ENGINEER; M. ASCE; contractor's manager or superintendent; 25 years' responsible charge of construction of dams, bridges, marine and subaqueous construction and operations; qualified to assume charge of administrative, technical and field operations. Location immaterial. C-598-504-A-1.

CIVIL ENGINEER; Assoc. M. ASCE; 40; married; Illinois and Missouri professional engineer licenses; B.S. in C.E.; 15 years' varied experience in construction including utilities, mill, factory, building materials, time as field engineer, superintendent research engineer; veteran willing to travel; will relocate anywhere including foreign. Available immediately. C-599-294CE.

GRADUATE CIVIL ENGINEER; Assoc. M. ASCE; 43; married; New York State P.E.&L.S. licenses; 18 years' experience in design of hydraulic structures; flood control, irrigation, hydroelectric plants, water supply; preliminary hydraulic investigations, cost comparisons, final design, specifications; willing to relocate. C-600.

Positions Available

ASSOCIATE OR FULL PROFESSOR, civil engineering, specializing in sanitary engineering, preferably with a doctor's degree. Salary, $5,000–$6,000 on a 9-month basis. Location, West. Y-3358-R6300(b).

CIVIL OR MECHANICAL ENGINEER, under 35, graduate, for water distribution system surveys. Work will be almost entirely in the field, and will involve some traveling. Locations, United States and South America. Salary, $3,600–$5,800 a year for foreign service. Company prefers married man, and will receive in addition to salary a cost-of-living bonus. Y-3373.

ASSISTANT SANITARY ENGINEER for the design of sewage-disposal plants. Must be capable of assuming responsibility for the various steps in design, and should be able to handle a squad of assistant designers and draftsmen. Location, Rhode Island. Y-3397.

SALES ENGINEERS, two, about 30, graduates, with highway construction experience, to promote and supervise the use of asphaltic products. Locations, one for Tennessee and the other for northern Alabama. Y-3398-R6345.

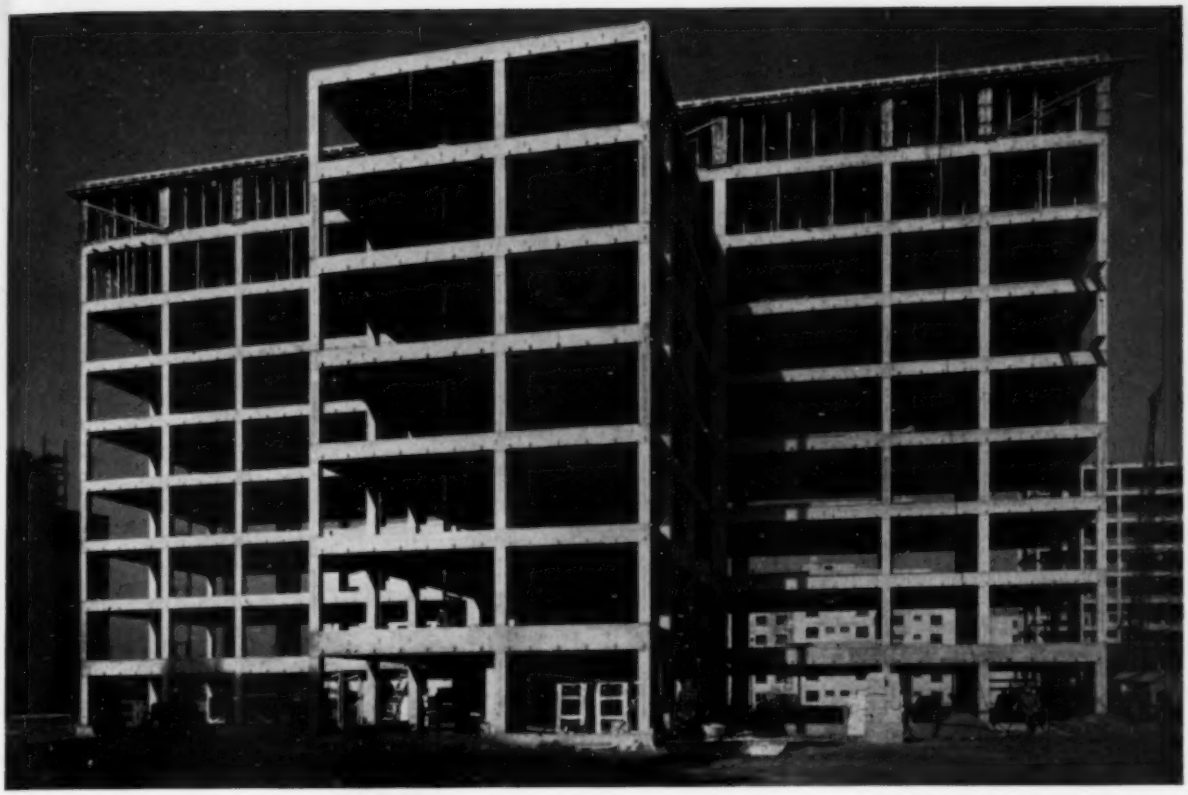
PROFESSOR in highway engineering with some practical experience. Spanish desirable, but not necessary. Salary, $6,000 a year plus living allowances and travel expenses. Location, Venezuela. Y-3411.

SALESMEN, three, 40 or under, with civil or architectural engineering background, for manufacturer of ornamental metal building products. Must read and understand blueprints and details as executed by architects. Salaries, $4,800 a year plus commissions and expenses, plus automobile supplied by company. Territories, Connecticut, Pittsburgh, and Canada. Headquarters, New York, N.Y. Y-3427.

CIVIL ENGINEER, 30–40, with construction experience covering highway, railroad, drainage, etc., for sugar mill plantation. Previous experience in Central America desirable. Salary, $5,000–$6,000 a year. Location, Caribbean Area. Y-3434.

CIVIL ENGINEER, young, with contracting experience, to supervise construction of small buildings with a native staff, and work with contractors on some larger extensions. Considerable maintenance and rebuilding necessary. Duration, 2 years, with possibility of permanent position. Salary, $6,000–$7,200 a year. Single status to start. Location, India. Y-3442.

(Continued on page 82)



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Dearborn Homes (above) in Chicago on State Street between 26th and 30th Streets is a typical example of concrete frame and floor construction. This apartment project consists of 800 units in 16 buildings. Four buildings are 9 stories and 12 are 6 stories in height. Loebl, Schlossman & Bennett are the architects, Frank A. Randall & Sons the structural engineers and S. N. Nielsen Co. the contractor.

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(*Continued from page 80*)

STRUCTURAL DESIGNERS AND SENIOR DRAFTSMEN, civil graduates, with at least 3 years' practical experience in the field of industrial buildings, to design and layout structural steel and reinforced concrete buildings. Must be citizens of the United States. Salary open. Location, Massachusetts. Y-3443.

PLANT ENGINEER, mechanical background, 40–45, experienced in food handling or products where sanitation is an element, requires knowledge of tanks, piping, refrigeration, heat exchange, construction methods, installation and modification of major plant equipment, and facilities and construction. Salary, $7,000–$8,000 a year. Location, Midwest. Y-3446-R6136.

DETAILER experienced in detailing structural steel, such as trusses, columns, beams, and open steel floor grating. Salary open. Location, South. Y-3454.

ASSISTANT TO GENERAL SUPERINTENDENT in the construction of a large powerhouse in northern Michigan. Salary, $6,500–$7,500 a year. Y-3457D.

SUPERINTENDENT OF CONSTRUCTION with 5 to 10 years' experience, preferably in the construction of a large industrial building or hospital or school building. Salary open. Location, New York metropolitan area. Y-3459.

PRINCIPAL with degree in civil engineering, with practical experience in the actual execution of large projects and their organization, and teaching and administrative experience in a recognized engineering institution. Salary, Rs. 2000-100-3000, plus overseas pay of 30 pounds per month. Residential accommodations provided at 10 per cent of pay. Location, India. Y-3471(s)

INSPECTOR, substantial experience in general construction; should know specifications, materials and acceptable construction from foundation to finish and trim (outside and inside). Will see that quality of materials, workmanship and conditions conform with requirements. Salary open. Location, Illinois. R-6280.

CONSTRUCTION SUPERINTENDENT, Civil Engineer, capable of assuming charge of erecting factory building of 100,000 sq ft. Able to handle building contract and supervise actual construction. Salary open. Location, Pennsylvania. R-6325.

DESIGNER (hydraulics), Civil Engineer, well experienced in and able to do board work on underground surface and overhead utilities for a large project. Will deal with conduit and concrete underground sections, utility galleries, manholes, catch basins, hydrants; knowledge of grades, drainage sanitation, etc. Salary, $350–$400 a month. Location, Illinois. R-6335.

ARCHITECTURAL ENGINEER, graduate, 24–35; a year's upward experience architectural design. Will design for sales-display offices; prepare working drawings, specifications, estimates on remodeling and new construction. Knowledge of interior decorating, lighting, and display equipment desirable. Salary, $3,000–$4,000 a year. Location, Illinois. R-6350.

DRAWING ROOM SQUAD LEADER, under 45; well experienced in consulting engineers' drawing rooms; able to deal with a variety of new construction problems and the selection and assignment of drawing room assistance as required; able to estimate, determine and maintain drawing room schedules and output of work. Will be concerned with preparation of plans, specifications and some estimating of construction, electrical and mechanical plans for general construction encountered in a beverage plant. Salary open. Location, Wisconsin. R-6357.

SALES ENGINEER, Civil Engineer or Mechanical Engineer, 25–30; background or knowledge of structural roof decks, fireproofing, acoustical, precast flooring and other construction. Able to take-off, estimate, and bid from plans and specifications. Will follow through with customers (users, general contractors and subcontractors). Salary, $300 a month, car furnished. Location, Illinois. R-6359.

(*Continued from page 78*)

T. Keith Legaré, executive secretary, National Council of State Boards of Engineering Examiners, Columbia, S.C., has been reappointed to the State Board of Engineering Examiners by the governor.

M. A. Dillingham, former chief of the Reports Branch of the Galveston, Tex., District of the Corps of Engineers, succeeds **H. R. Norman** as chief of the Engineering Division of the Galveston District. Mr. Norman has entered private consulting business and will be located in Houston.

Arthur R. Reitter, has been appointed city engineer of Lincoln, Calif., on a part-time basis. He is also city engineer of Colusa and Williams.

Fred H. Kellogg, chairman of the department of civil engineering at the University of Mississippi, has gone to India, to act as consultant to the government of India, on the Nangal hydroelectric project in East Punjab province.

R. R. Garnett is now in charge of railroad and highway relocations for the Walla Walla, Wash., District of the Corps of Engineers.

Martin H. Blote has been appointed acting superintendent of the Central Valley Project of the U. S. Bureau of Reclamation in anticipation of new work in that area.

Clarence J. Derrick has resigned as president of the Los Angeles, Calif., Board of Public Works, to reenter consulting engineering practice.

Lorenz G. Straub, director of the University of Minnesota's St. Anthony Falls Hydraulic Laboratory, has accepted an appointment as civilian member of the Beach Erosion Board of the Corps of Engineers for a four-year period. Dr. Straub is head of the department of civil engineering in the university's institute of technology, and engineering consultant to the Division of Waterways of the Minnesota Department of Conservation.

Stanley E. Sporseen, civil engineer with the Portland, Ore., District of the Corps of Engineers, has been loaned by the Department of the Army to act as adviser to the Venezuelan Ministry of Public Works for one year. At Caracas, Mr. Sporseen's duties will include selecting types of hydroelectric and irrigation dams, planning and designing dams, and outlining over-all specifications for their construction.

Herbert G. Crowle, chief of the Corps of Engineers regional flood control staff at Oakland, Calif., has been appointed engineer of the new Alameda County Flood Control District.

Perley M. Lewis, who is special engineer in charge of the water system expansion of Phoenix, Ariz., has been made head of the Water Department there.

E. E. Woodward, formerly engineer-manager of the Fort Worth, Texas, expressway, has become principal engineer-consultant on an investigation of the highway needs in the Rio Grande Valley of Texas. **Frank E. Lovett** will succeed Mr. Woodward at Fort Worth. Other changes include **M. C. Welborn** to senior engineer of special services at Austin, and **Frank W. Cawthon** to district engineer at Dallas.

Charles Elcock is now connected with the firm of Birkinbine Engineering Offices with headquarters in Philadelphia, Pa.

F. R. Burnette has been named assistant-vice-president–engineering of the U.S. Steel Corp., of Delaware.

Howard F. Eckerlin announces the opening of new offices in Syracuse, N.Y., for the practice of civil and structural engineering.

Ben G. Watkins and **M. M. Vogel** have formed a partnership for the practice of engineering, with offices at Winsor Terrace, N.C.

Robert C. Browning announces the establishment of an office for the practice of structural and mechanical engineering, at 1918 Hillsboro Street, Raleigh, N.C.

PHOTOGRAPHED DURING RECENT CORPS OF ENGINEERS SAFETY CONFERENCE at Galveston, Tex., are, left to right, Nathaniel Jensen, district safety engineer; Lt. Col. Ellsworth I. Davis, Assoc. M. ASCE, district engineer; Kenneth Smith, M. ASCE, chief of Construction Division; and S. S. Elkins, Southwestern Division safety engineer. In address given by Colonel Davis teamwork between contractors and Corps of Engineers to improve safety record of many projects under construction was stressed.

145-h.p. Series F-8 Big Job, with special tandem rear axle, one of over 175 Ford Economy Truck models, has an allowable G.V.W. rating as a six-wheeler of 35,000 lbs.

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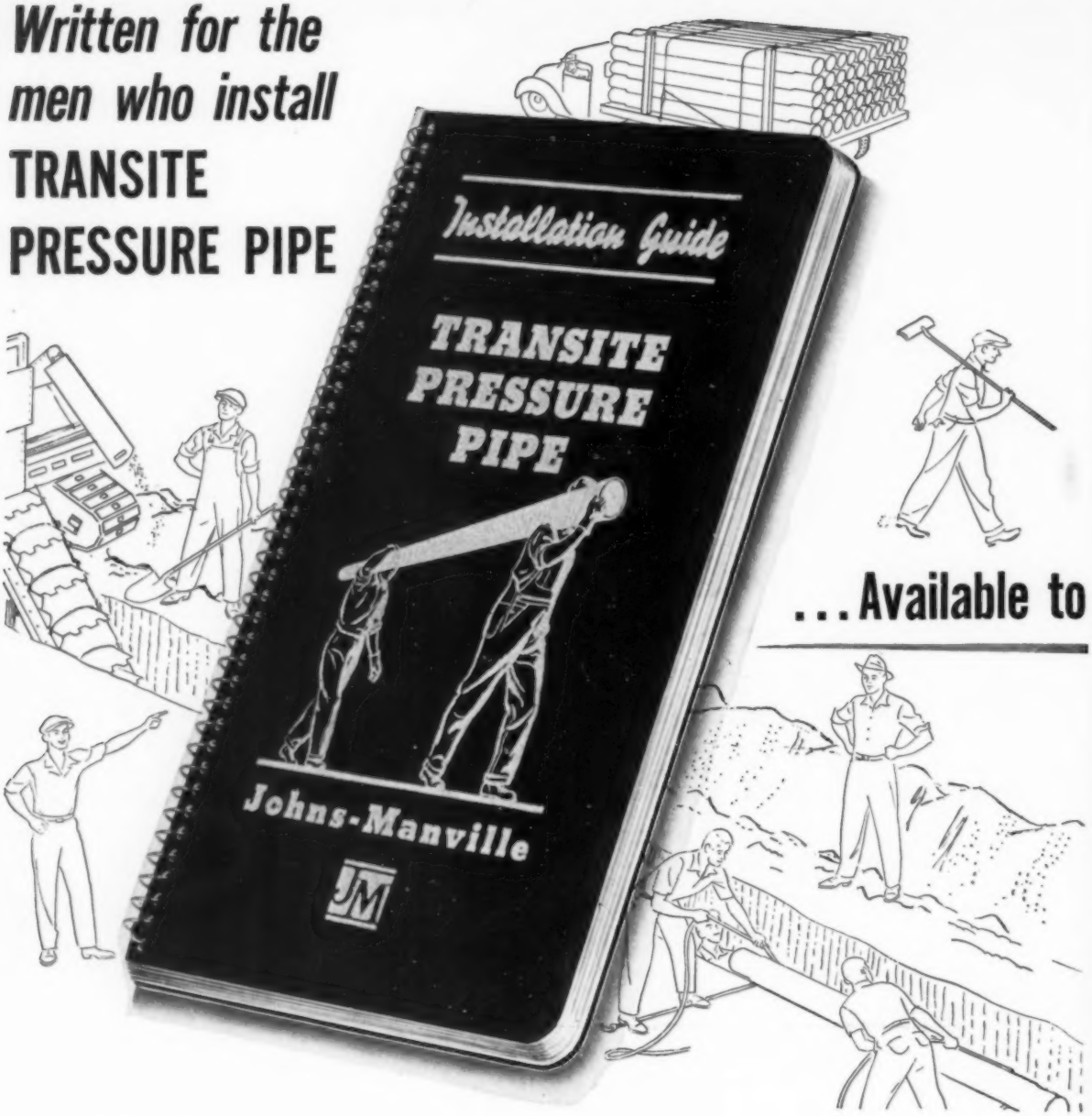

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FOR BETTER

New Publications

Engineering Research. Research as essential to engineering progress is the theme of the Proceedings of the 1949 annual meeting of the Engineering Research Council of the American Society for Engineering Education, which is just off the press. In addition to a symposium on instrumentation for engineering research, the publication reports research policies and goals of colleges and universities and research interests of such groups as the Army, the Navy, the Air Force, the Public Health Service, the Highway Research Board, and the Department of Agriculture. Copies of the 140-page publication may be ordered from the Office of the Chairman of the Engineering College Research Council at the State University of Iowa, Iowa City, Iowa, at $2 each, postpaid.

Highway Construction. To familiarize construction personnel, students, engineers from foreign countries, and others with highway construction techniques currently in use in the United States, the American Association of State Highway Officials has published a 181-page *Manual of Highway Construction Practices and Methods*. The publication covers in considerable detail soils, drainage, earthwork, base and surface courses, untreated base and surface courses, soil-cement base courses, soil bitumen, bituminous base courses, and portland cement concrete. Copies, priced at $2.50, may be purchased from the AASHO, 1220 National Press Building, Washington 4, D.C.

Zoning. Major aspects of modern zoning practice are discussed in a 43-page pamphlet recently issued by the Construction and Civic Development Department of the Chamber of Commerce of the United States. Designed to stimulate constructive thinking about the use of zoning to promote sound urban growth and development, the booklet is the work of a special committee of professional city planners. Prices range from 30 cents for single copies to 15 cents a copy in lots of 20 or more. Inquiries should be addressed to the Construction and Civic Development Department, Chamber of Commerce of the United States, Washington 6, D.C.

Tennessee Valley Authority. Publication of its Technical Report No. 11, detailing the planning, design, construction, and initial operation of the Fort Loudoun Project on the Tennessee River, is announced by the Tennessee Valley Authority. The 533-page report, containing 187 illustrations and exhibits, is available from the TVA, Treasurer's Office, Knoxville, Tenn., for $2.

Snow Surveys. Analyses of results obtained in snow surveys for forecasting stream flow in western Nevada are reported in Bulletin No. 184 of the University of Nevada Agricultural Experiment Station, by Horace P. Boardman, for 20 years chairman of the Forecast Committee of the Nevada Cooperative Snow Surveys. Inquiries should be addressed to the Agricultural Experiment Station at Reno, Nev.

Pacific Gas & Electric Spends ¾ Billion on Expansion

(*Continued from page 30*)

an endless cable, were used to hoist concrete and steel parts from the nearest access road. The cable passed through a sheave above the tower site and around the drum of a hoist, making it possible to shuttle the torpedo, or "pig" as it was nicknamed, back and forth between the concrete plant established at the nearest access road, and the tower site. This device readily cut its own path through the soft ground or along the rocky slopes prevalent in the canyon, and proved an efficient and rapid method of handling these materials.

Tower steel was assembled in sections on the ground and the sections hoisted into place. The tower line and Rock Creek Powerhouse were put in operation in March 1950, completing the five plants included in the postwar expansion program.

The five plants and appurtenant structures were all designed by the Company's Engineering Department. Construction was performed by qualified contractors on the basis of competitive bidding, and was coordinated and supervised by the Company's Construction Department.

Value of Snow Surveys Shown by Long Experience

(*Continued from page 49*)

by May 1 the range between maximum and possible minimum ought to be narrowed down considerably. For some streams preliminary gagings are available monthly, from which a rough estimate can be made of the total discharge since the previous October 1. If this estimated total runoff to date were subtracted from the current annual forecast it would give the expected runoff for the remainder of the water year. However, the Weather Bureau forecasts do not include such deductions, so they are not forecasts in the sense of telling what is to follow a given date.

The question naturally arises as to how the results being obtained would compare over a period of years with those obtained by a series of 8 or 10 Weather Bureau precipitation gages if it were feasible to install them in place of the single gages now used at the few Weather Bureau stations operating in heavy snow country. Anyone with an intimate experience with the standard gages, even when equipped with modern shields, knows that they do not always get a fair catch of snow.

HORACE P. BOARDMAN, M. ASCE
Emeritus Professor of Civil Engineering, University of Nevada
Reno, Nev.

Recent BOOKS

BETON-KALENDER 1945–1950. Edited by Verlag der Zeitschrift Beton- u. Stahlbetonbau, 39th Jahrgang. Verlag von Wilhelm Ernst & Sohn Berlin, 1949. 640 pp., illus., diagrs., charts, tables, 6 × 4¼ in., stiff cardboard, 10 DM. The 39th edition of this standard handbook on concrete and steel-reinforced concrete construction includes such basic information as mathematical tables, solution of equations, geometry, tables of building materials, mortar and concrete manufacture, strength of materials, structural analysis, analysis of structural parts made from steel-reinforced concrete, and general constructional considerations.

(The) BUSINESS OF HOME BUILDING. By B. K. Johnstone and C. E. Joern, Editors. McGraw-Hill Book Co., New York, Toronto, London, 1950. 289 pp., charts, tables, 8¼ × 5½ in., cloth, $4. Written by a group of experts in the field, this book is specifically designed to help the small building contractor. It provides a practical knowledge of the business covering both economic factors and production data. Land, working capital, job organization, cost control, sales, and legal aspects are important topics covered.

DREDGING OF HARBOURS AND RIVERS. By E. C. Shankland. Brown, Son & Ferguson, Ltd., 52-58 Darnley St., Glasgow, S.1, Scotland, 1949. 266 pp., illus., diagrs., charts, maps, tables, 9 × 6½ in., cloth, $6.50. Based on the author's experience in the practice of river and harbor operations, this volume combines the operation of dredgers with the economics of typical performance, and describes the hydrographic work leading up to and following dredging. Details of equipment and operating procedures are thoroughly covered particularly with regard to current practice.

ELEMENTARY REINFORCED CONCRETE DESIGN. By W. Morgan. Longmans, Green & Co., New York; Edward Arnold & Co., London, 1949. 303 pp., diagrs., charts, tables, 8¾ × 5½ in., fabrikoid, $3. Written for students of architecture and building, this book considers the design of various structural units of normal reinforced concrete. Prestressed concrete and other special aspects are not covered. Bending moments and shear forces are considered in the early chapters, together with other design fundamentals. The later chapters provide detailed treatments of practical applications dealing with beams, columns, slabs, floors, staircases, etc.

ENGINEERING MECHANICS. By A. Higdon and W. B. Stiles. Prentice-Hall, Inc., New York, 1949. 505 pp., illus., diagrs., charts, tables, 9¼ × 6 in., cloth, $6.65. This basic text stresses the fundamental principles of engineering mechanics and the development of the ability to apply them. Equal emphasis is placed on statics and dynamics. Where possible, an action is illustrated by the use of free body diagrams or other pictorial and semigraphical aids as a supplement to the use of elementary calculus. Over 1,100 problems are included, of which about 100 are set up as illustrative examples. The appendix includes answers to the even-numbered problems.

FERTIGKONSTRUKTIONEN IM BETON- UND STAHLBETONBAU. 3rd rev. ed. By A. Kleinlogel. Verlag von Wilhelm Ernst & Sohn, Berlin, 1949. 128 pp., illus., diagrs., 9½×6¾ in., paper, 10 DM. This book discusses the use of small prefabricated reinforced-concrete units in a variety of structures. Brief design data are given for the construction of public, private, and industrial buildings, bridges, railroad stations, retaining walls, levees, tunnels, and canals.

HANDBOOK OF RIGGING. By W. E. Rossnagel. McGraw-Hill Book Co., New York, Toronto, London, 1950. 321 pp., illus., diagrs., charts, tables, 9¼×6¼ in., cloth, $4.75. Designed as a handy reference for daily use, this book, written for the average workman, contains the methods essential to more effective rigging practices in construction and industrial operations. Confined to technical phases of rigging, it covers fiber and wire rope, hoisting chains and hooks, cranes and derricks, scaffolding, painting and repairing steel stacks, and many other related topics. Charts, tables, and diagrams are included.

LEGAL PHASES OF ENGINEERING: Contracts and Specifications. By I. C. Crawford. Macmillan Co., New York, 1950. 346 pp., tables, 8½ × 5½ in., cloth, $3.75. This textbook has three main objects: To acquaint the student with legal relations peculiar to the engineering profession and its daily business experiences; to promote an understanding of the process employed by the courts in arriving at a final decision; and to develop an appreciation of clear, concise contracts and specifications. Actual cases are used as illustrations.

Positions Announced

U.S. Civil Service. The Navy is seeking qualified engineers to fill certain positions in the Boston, Mass., District Public Works Office. The following opportunities may be of interest to civil engineers: Construction Engineer, GS-11 (formerly P-4), $5,400 per annum; Construction Superintendent, GS-9 (formerly P-3), $4,600 per annum; Civil Engineer, GS-11 (formerly P-4), $5,400 per annum; Civil Engineer, GS-9 (formerly P-3), $4,600 per annum. Applications should be on Standard Government Form 57, obtainable at any Post Office or Civil Service Office, and should be forwarded to the District Public Works Officer, First Naval District, 495 Summer Street, Boston 10, Mass.

Blending of Sewage Effluent with Natural Waters Permits Reuse

(*Continued from page 41*)

Although industrial requirements vary widely as to quality, they are generally fairly uniform as to demand. The seasonal requirements of agriculture usually do not obtain in industries where reclaimed waters are acceptable, and these industries therefore lend themselves well to the utilization of a steady supply of water.

Some industrial wastes render sewage unfit for reclamation and reuse. Heavy discharges of oil and grease; solvents; concentrated acids; poisonous compounds; brines; aromatic compounds such as phenols; and a variety of other troublesome substances, if allowed to enter the sewerage system may seriously limit the usefulness of the reclaimed waters.

Water reclamation from sewage depends primarily upon the application of sound, established engineering principles, and in applying these principles two basic concepts should be kept in mind: First, that water reclamation from sewage is a process separate and distinct from sewage treatment; and second, that public acceptance of unrestricted re-use of sewage waters depends upon the inclusion of a "natural" purification process—a blending with lake, river, or underground waters.

EQUIPMENT, MATERIALS *and Methods*

NEW DEVELOPMENTS OF INTEREST.. AS REPORTED BY MANUFACTURERS

Versatile Earth Mover

THE INTRODUCTION OF A new 1 cu yd machine, the Marion Type 43-M, has been announced. With various front-end combinations, the 43-M serves as a shovel, dragline, clamshell, crane, backhoe and pile driver. The unit is designed for a wide range of applications in construction, industrial plants, bridge and road work, drainage and reclamation, quarrying, and coal and metal mining. The machine features versatility, mobility and portability and gets around rapidly under its own power and crawls aboard a carry-all for quick movement from one job to another. Front-end changeovers in the field can be made quickly and easily. Simplicity of design eliminates the need for machinery, lagging or sprocket changes in making front-end conversions. A single boom can serve for both shovel and backhoe work, but a gooseneck boom is optionally available for owners who prefer it for backhoe service. A single boom, with butt-jointed sections, is used for dragline, clamshell, crane or pile driver service.

Marion Type 43-M

The 43-M lower frame and crawler assemblies combine cast and welded construction. Crawler rollers are shielded from dirt, and the crawlers are self-cleaning and non-clogging. The swing gear has machine-cut, hardened teeth and the swing roller path is extra wide to accept the six wide, large-diameter swing rollers. Bulletin No. 400, describing the Marion Type 43-M machine may be obtained by writing direct to the company's main offices. **Marion Power Shovel Co., Marion, Ohio.**

Scaffolds

ALUMINUM ALLOY "TUBE-AND-COUPLER" scaffolds, basically different from any other scaffolds on the market, have been announced. Designed for heavy construction work and for industrial maintenance, Up-Right aluminum alloy scaffolds can be erected in any size or shape and have the following exclusive labor-saving features: erection and dismantling time and cost cut in half, transportation time and cost cut in half, double load-carrying ability, 1/3 greater strength than iron pipe tubing of similar diameter, no rust and dismantled parts pass through smallest manholes. Since the weight of a scaffold itself is usually an important part of the total load on the structure, aluminum alloy scaffolds are less severely stressed than those of steel. Greater resilience provides warning of excess loading before danger point is reached. Aluminum alloy has three times the ability of steel to withstand impact load. **Up-Right Scaffolds, 1013 Pardee St., Berkeley, Calif.**

Bottom-Dump Hauler

FOR BOTTOM-DUMP HAULING the Model E-16 Tournahopper powered by the C Roadster Tournapull prime mover is available with a choice of three engines. The Tournahopper has a heaped capacity of 16 tons or 15 cu yds. Its 9 ft 2 in. by 9 ft 2 in. bowl presents an easy target for shovel or dragline to hit and fill. Its bottom-dump doors operate in a manner similar to a clamshell, swinging upward along the outside of the Tournahopper bowl as they open. Positive electric control of the self-cleaning doors permits controlled ejection by opening the doors to any desired width. Where controlled ejection is unnecessary, the doors can be opened to full width, thus making possible extremely fast ejection. The 90° left and right turning angle gives the rig a minimum turning radius of 14 ft. This, plus multiple disc air brakes on all four wheels and positive electric power steer, make it safe and easily maneuverable. **R. G. Le Tourneau, Inc., Peoria, Ill.**

Tractair Mobildrill

A ONE MAN OPERATED, self-contained, self-propelled wagon drilling unit, utilizing Le Roi's 105 tractair tractor-compressor, has been developed. It is designed for faster and easier drilling operations in quarry, gravel pit, road cut and strip mine applications. The Mobildrill consists of a swinging boom which extends out from the tractair platform and a universally mounted wagon drill guide shell for 6 ft steel change. The Mobildrill is flexible enough to drill angle, vertical or horizontal holes at any elevation and can be equipped with an air motor powered boom. One man can handle every phase of drilling, including the simplified moving of equipment between drilling locations and blasting sites. The 35 hp tractor is capable of operating over rough terrain and eliminates the need for trucks or extra help to move wagon drill and compressor. Bulletin T16, entitled "Drive Your Wagon Drill and Compressor" has been prepared to cover this product. It may be obtained by writing **Le Roi Co., 1700 S. 68th St., Milwaukee 14, Wis.**

Rollers

A NEW LINE OF variable weight 3-wheel rollers, which are equipped with ballast-type rolls have been manufactured. These rolls are constructed with heavy steel rims, welded to steel head plates and form with the hub a watertight compartment. Filling and drain plugs are installed in the outer heads to facilitate ballasting. On models where wet sand ballast is recommended, a shovel opening

with bolted watertight cover is also provided in the outer head. One variable weight unit now covers a weight range equal to three fixed capacity models. Machine-finished roll surfaces enable these rollers to be used on finishing work, as well as on subgrades and stone. Thus one machine can now do work formerly requiring two or more rollers, thereby permitting savings in equipment investment and eliminating need for extra rollers, which only work part time on the job. The manufacturer's catalog S-60-50 is available upon request. **Buffalo-Springfield Roller Co., Springfield, Ohio.**

Equipment, Materials & Methods (Continued)

New Shovel

A NEW 5½ YD SHOVEL, crane and dragline, Model 4500, has been manufactured. Especially designed for mobility, this machine has air controls for all operating clutches and brakes, straight Diesel power and crawler drive which make it adaptable for any locality or terrain. On the job, travel speed is 0.77 miles per hr, with ground, bearing pressures are as low as 9.6 lb per in. Standard crawlers are 25 ft 9 in. long and 21 ft wide with choice of 48 in. or 60 in. pads. Steering is air controlled from the operator's cab through jaw

Model 4500

type clutches. These permit positive locking of either crawler, for short radius turns in either direction. Both carbody gearing and steering clutches are enclosed with gears running in an oil bath. Optional dragline and clamshell boom lengths vary from 100 to 140 ft, with the upper 75-95 ft made of aluminum alloy. All-steel liftcrane booms are available in lengths from 87 ft up, with crane rated lifting capacity of 100 tons at a 20 ft radius. Before public announcement of the Model 4500, it has been proven in the field by work on a number of typical jobs. Full explanation of features, plus detailed specifications are included in a 16-page bulletin, No. 45-50, with full color cover and many photographs. **Manitowoc Engineering Works, Manitowoc, Wis.**

Air Conditioner

CULMINATING MONTHS OF RESEARCH and development, a completely new line of central system weathermakers, incorporating the most advanced features in applied air conditioning techniques, is announced. Lighter in weight, more powerful in performance and quieter in operation, the new units, Models 39S and 39T, are available in sizes to cover a range of from 5 to 75 tons of refrigeration capacity. They are completely sectionalized to provide ready assembly on the job to meet virtually all job conditions. The unusually heavy insulation in the fan section is non-combustible and non-hygroscopic, thereby preventing condensation and rusting on the outside of the unit. The cooling coil section is set at a 45° angle, affording increased cooling surface and a high airway velocity. This produces high capacity cooling in proportion

(*Continued on page 92*)

Equipment, Materials & Methods (Continued)

to size and weight of the unit. The units are adaptable to either automatic or manual control. Dampers are opposite acting and interlocking, with felt edgings to give air tightness when in a closed position. All sizes are available in sections or components that permit assembly in either vertical standing position or as a horizontal ceiling suspended unit. **Carrier Corp., Syracuse, N.Y.**

Asphalt Surface Heater

THE CLARKMOORE ASPHALT surface heater, designed for resurfacing of sheet asphalt, rock asphalt, asphalt block and plant-mix, has just been announced. Worn and corrugated pavements can be restored to their original efficiency with a saving of approximately 35%. Heater is used to prepare the surface of old pavements for removal by the application of intense heat. The unit is mounted on a specially built 2½ ton Diamond T truck chassis, having a low-speed rear axle, and extra low speed in the transmission.

The Clarkmoore Heater

Special controls are provided on the steering column to enable the operator to move the machine without getting into the cab or driver's seat. All operating parts are completely enclosed within the rigid steel body which houses the fuel oil tank, gasoline tank, engine, blower, pumps and hydraulic hoist. This surface heater is equipped with a Clarkmoore fuel oil burner. Fuel oil is forced into the heater under pressure, properly mixed with air. Heat from this single burner is deflected by the surface of the hood to the pavement. The even intense heat makes possible the bonding of the original pavement and new material into one solid mass that will not creep, bulge or slip on the base. **Asphalt Maintenance Co., 41 Park Row, New York 7, N.Y.**

Rubber Pads

A PROCESS FOR VULCANIZING resilient rubber to steel plates, which when bolted to crawler pads permit movement of pavers over finished concrete without damage to the surface, has been announced. Metalweld uses B. F. Goodrich Vulcalock bonding process in the rubber lining work, and rubber and steel are joined together with a bond strength of over 500 lb per sq in. according to the firm. Metalweld points out that the use of these rubber pads eliminates the expense of labor necessary to continually relay belting and also enables the contractor to progress faster with paving operations. **Metalweld, Inc., 26th & Hunting Park Ave., Philadelphia 29, Pa.**

Equipment, Materials & Methods (Continued)

Mighty Mower

THE BUSHWACKER IS ACCEPTED as being the first successful mechanical method for clearing access lanes to utility lines. The Bushwacker has demonstrated its amazing ability to completely obliterate every trace of vegetation including trees up to 8 in. in dia. In a single pass it literally disintegrates all brush, vines and under-

Bushwacker

growth leaving in its wake only fragmented evidence of former growth. The design of the Bushwacker, while unique, is quite simple. Its mowing and shredding action is achieved by 20 steel "flails" that rotate at a peripheral speed of 11,550 ft per min. These flails weigh almost 20 lb apiece and are attached by chains to a steel drum which revolves on the front of the machine at 1050 rpm. Power for the mighty mower is a General Motor's 2 cycle Diesel engine with a rating of 168 hp. This engine was chosen because of its low weight to horsepower ratio and its ability to provide instantaneous response to changing loads. **American Steel Dredge Co., Inc., Ft. Wayne, Ind.**

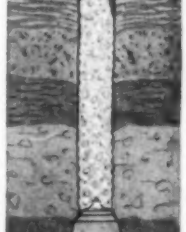
Site-Casting

"SITE-CAST," A MODERN DEVELOPMENT of the concrete pipe industry, saves time and money on sizable projects requiring large-diameter pipe where existing plants cannot furnish the specified material. In simplest terms, the process consists of moving the plant to the site of the project. An interesting application of site-casting was made recently on a storm sewer project at Midland, Michigan. The problem was to construct a direct drainage outlet about 1 mile long through the center of the city. Plans were prepared on the basis of tunneling and of open cut, using precast concrete pipe. The first step in site-casting was to bring in molds, forms, cores and pipe making equipment. A stationary concrete mixer was set so it could discharge into trucks which backed in below. By using internal vibrators after pouring the forms, project workers were able to get pipe of uniform strength and density. The cured pipe was loaded by crane onto a flat-bed trailer. At the job another crane lowered the pipe into its position in the trench. Pipe handling was facilitated by a lifting hole in each section and a curved interior support which distributed the stress. **Byer & Bowman, 203 E. Broad St., Columbus 15, Ohio.**

Equipment, Materials & Methods (Continued)

Button Bottom Piles

It is reported by Western Foundation Corporation that frictional capacity developed by their Button Bottom piles has increased bearing capacity as high has 1500%. The unusual friction value of this type of pile is attributed to its unique construction. In the majority of cases, the true bearing value of a friction pile will be proportional to the volume of soil it displaces in the bearing stratum. The enlarged button at the point, and the cylindrical shaft of a Button Bottom pile give a greater volume displacement where it



Section of Pile

counts, than a "top-bearing" or tapered pile. During driving, there is little frictional value; however, when the soil reforms around the shaft, frictional values developed are of unusual proportions. This increment is an additional safety factor over and above the value indicated by the driving resistance. Remolded soil of the soft clayey types will develop far greater strength than it had in its undisturbed, pre-driving condition. If the soil is a fine silt, it will quickly return to the strength it had prior to being disturbed. **Western Foundation Corp., 2 Park Ave., New York 16, N.Y.**

Light-Duty Truck

A LIGHT-DUTY, FOUR-WHEEL-DRIVE truck is now being introduced to a major segment of the truck field. The new FWD, identified as Model LD, has a gross vehicle weight of 14,500 lb. While the new Model LD will have its place in off-the-highway service, it also is said to have high efficiency on the road. Initial applications are scheduled for highway maintenance, municipal service, oil-field operations, general construction, telephone and electric-line construction and maintenance, industrial shuttle service and certain types of public transportation. **The Four Wheel Drive Auto Co., Clintonville, Wis.**

Equipment, Materials & Methods (Continued)

Motors

POWER STATION AUXILIARY MOTOR—A new modified base-ventilated motor, designed specifically for external applications such as driving power station auxiliaries mounted out-of-doors, has been announced. Available in ratings ranging from 200 to 3000 hp, the motor was developed for those outdoor installations where the totally-enclosed fan-cooled units are not available. G-E engineers point out that this is not a standard motor compromised in an attempt to do a non-standard job, but is an entirely new design. The motor is designed to be mounted on a concrete base which is raised sufficiently from the ground to allow contaminated ambient air to flow through the foundation at high velocity, as in a storm. In case air enters the exhaust ports during a heavy storm, adequate elimination and drainage are provided. Such an exhaust system makes it possible to provide good protection, and yet eliminates the duct work necessary to separate intake and exhaust vents when both are located in the base of the motor. Additional information on the modified base-ventilated motor is contained in Bulletin GED-1232.

GIANT MOTORS—Two giant 65,000 hp synchronous motors, believed to be as powerful as any motors ever built, have been manufactured for use in the Columbia Basin Irrigation Project in Washington. They will be installed in the new pumping plant at Grand Coulee Dam on the Columbia River. The motors will drive the world's largest pumps, each capable of pumping enough water to equal the daily requirements of 35 cities the size of Schenectady, New York. The huge G-E motors each weigh more than 330 tons, and are 25 ft high and 100 ft around the base. **General Electric Co., Schenectady 5, N.Y.**

Admix Meter

THE DEVELOPMENT AND AVAILABILITY of a new admix meter specifically designed for installation on either the Koehring 16-E or 34-E Twinbatch pavers has been announced. The attachment is also suitable for use in connection with water batchers in ready-mix or central mix plants. The admix meter is designed as a metering device for automatically measuring a predetermined quantity of a liquid air entraining agent into the concrete batch. Entirely mechanical, movement of the paver skip actuates the meter. The meter directs the air entraining agent into the mixing drum with the water and provides numerous advantages in quality, handling and durability of concrete. This is made possible because air content of concrete can be controlled and regulated by varying the amount of admix added at the paver rather than in the cement itself. Additional and complete details on the design and application of the admix meter may be obtained from the **Koehring Co., 3026 West Concordia Ave., Milwaukee 16, Wis.**

Above: Section of typical echo depth recording showing depth and bottom contour. Clearly reveals composition: Mud, rock, etc. Precision recorder prices begin at $3300.

Equipment, Materials & Methods (Continued)

Surveying Equipment

A COMPLETE NEW LINE of surveying instruments has been introduced into the United States by Fennel & Sons of Germany. The instruments are lightweight, totally enclosed, climate-proof units designed for both rugged construction duty and high-precision geodetic work. The

new line includes transits, levels, theodolites, and charting instruments, plus accessories such as plumb bobs, rigid bobs, rods, steel tapes, tripods, and optical plummets for centering transition theodolites and tacheometers. Principal instruments in the line are seven of the transits; seven types of levels in three different sizes; and the new auto-reduction Hammer-Fennel tacheometer. Further details may be secured from **Norbert Dienstfrey, 478 Water St., New York 2, N.Y.**

Power Shovel Crane

THE LORAIN-50 IS a new power shovel-crane recently introduced. The machine is rated in the 1 yd. class and is claimed to be the first machine in this class equipped with a hydraulic coupling as standard equipment. The power take-off on the Lorain-50 is by means of a Twin-Disc Hydraulic Coupling. It is claimed this device prevents stalling the engine due to any digging circumstances and that it provides a means of absorbing digging stresses and strains before they are transferred into the operating mechanism and the cables. Other turntable features include turntable rollers, mounted on Timken roller bearings, of a special design in which the roller itself serves as the outer race for the roller bearing. The swing clutches are wider and are of the floating anchor shoe type which gives more complete band contact and improved distribution of pressure. A complete line of interchangeable boom equipment is provided for the Lorain-50 as follows: shovel equipment, crane boom lifting cranes, clamshells, dragline and hoe. More complete information is available from **The Thew Shovel Co., Lorain, Ohio.**

Literature Available

PUMPS—A 16-page 2-color booklet entitled "Thruput Pumps for Water-Borne Solids" is offered. The booklet discusses general arrangement of horizontal unit, types of impeller and casing and methods of drive. Pictures, tables of dimensions and capacities are included. **Drysdale & Co., Ltd., Bon-Accord Works, Yoker, Glasgow, W. 4, Scotland.**

BRIDGE FLOORING SYSTEM—A new structural plate steel bridge flooring system is described in a 4-page technical bulletin. Lightweight and quick to install, USF structural plate bridge flooring is recommended for bituminous surfaced roadways on bridges, viaducts, overpasses and similar structures. Along with photographs of a highway bridge in various stages of construction, the bulletin includes a complete engineering description and a drawing which details all component parts. **United Steel Fabricators, Inc., Wooster, Ohio.**

WAGON DRILLS—Bulletin H-1200-B36A describes in detail Worthington wagon drills. The 10-page, illustrated bulletin describes three models: UMW-40 equipped with a 4 in. cylinder bore; UMW-35 equipped with a $3^1/_2$ in. cylinder bore; and UMW-30 with a 3 in. cylinder bore. The wagon wheel base of each model is 6 ft 3 in. **Worthington Pump & Machinery Corp., Construction Equipment Sales Div., Holyoke, Mass.**

STEEL FLOORING—A bulletin on various designs of open steel flooring has just been published. It describes and illustrates forged and welded rectangular reticulated pattern of this type of flooring for a wide variety of purposes, including industrial floors, platforms, walkways, bridges, safety steps, drain grates and trench covers; and also pallets, grid trays and tote boxes. The bulletin also gives dimensions of each design of grating and safety step and includes a safe load table. **Dept. 5, Kerlow Steel Flooring Co., 21 Mallory Ave., Jersey City 5, N.J.**

PLASTIMENT—Progressive engineers, architects and constructors creating new designs and methods use Plastiment because it helps them take full advantage of the inherent properties of concrete. A 4-page folder describes and discusses the first prestressed concrete bridge in the United States being built in Philadelphia, Pa.—with Plastiment concrete. **Sika Chemical Corp., 35-49 Gregory Ave., Passaic, N.J.**

SHOVEL CRANES—Catalog No. 2322, which contains applications, construction details, customer benefits and specifications of the HC-51 truck-mounted shovel-crane with speed-o-matic hydraulic controls, has just been published. Paramount features of the HC-51 are fully hydraulic speed-o-matic controls, front drum reversing mechanism for power control load lowering and a heavy duty carrier specifically designed for truck-crane operation. Link-Belt engineers have incorporated many other proven Link-Belt Speeder design features into this machine for more efficient performance. **Link-Belt Speeder Corp., Cedar Rapids, Iowa.**

Literature Available (Continued)

DIESEL ENGINES—Diesel engines for stationary installations are described and illustrated in a 20-page bulletin, No. 4812. The bulletin features 60 yrs of Superior engine research and production development, and numerous installations of these engines within the past three years in municipal power plants, in public utility power plants, industrial power plants, office buildings and others. Included are more than 100 engine specifications. Copies are available from **Superior Engine Div., The National Supply Co., Springfield, Ohio.**

TORQUE CONVERTERS—Publication of a 24-page 3-color booklet entitled "The New General Motors Diesel Engine—Torque Converter Unit" has been announced. In the pages of this illustrated booklet is complete information concerning what a torque converter is and how it functions—where and how it has been applied—and an invitation to power machinery users everywhere to use Detroit Diesel facilities in engineering particular applications in any field. **Detroit Diesel Engine Div., General Motors Corp., 13400 W. Outer Drive, Detroit 28, Mich.**

MOTORS—An 8-page 2-color bulletin on Tri-Clad high-speed synchronous motors has been announced. Designated as publication GEA-5426, it lists some of the applications for these motors, such as driving pumps, grinders, compressors, saws, beaters, fans, generators, conveyors, mixers, etc. Profusely illustrated, the bulletin gives three typical installation stories, describes Tri-Clad protection, and discusses construction features, mechanical modifications, and direct-connected exciters for the motors. **General Electric Co., Schenectady 5, N.Y.**

AIR DIFFUSERS—A 68-page selection manual that makes the choice of proper air diffusers much easier, has been announced. The manual tells how to calculate required air volume, then explains the technique of locating diffusers and determining number of units required. A selection chart shows photos and characteristics for 13 different diffuser types. In this chart are recommended application data together with information on rate of air changes per hr. Requests for the Anemostat selection manual should be addressed on your company letterhead. **Anemostat Corp. of America, 10 E. 39 St., New York, N.Y.**

STREET LIGHTING—"Planned Street Lighting for Public Safety" is the title of a 28-page illustrated booklet. Published to provide practical help in the promotion of better street lighting, useful help in the understanding of the street lighting problem, and to develop a workable outline to be used in planning street lighting programs. Street lighting luminaire distribution types are defined, and recommendations are made concerning their application. For a copy of this booklet (B-4332) write the **Westinghouse Electric Corp., Box 2099, Pittsburgh 30, Pa.**

(*Continued on page 100*)

Literature Available (Continued)

WIRE ROPE—A 4-page 2-color booklet entitled "Ropeology" discusses the latest uses for wire rope. A brief description is offered on the use of wire rope for transformers, pit operations and air-borne lifeboats. Pictures and diagrams are included. **Mac Whyte Co., Kenosha, Wis.**

MOTO-MIXERS—Bulletin No. 50-10 illustrates and describes Rex horizontal moto-mixers and the sensational new, Rex adjusta-hite discharge moto-mixers. This 16-page bulletin gives detailed descriptions of the many features. Cut-away views, job illustrations and dimensional drawings clearly show these features in operation and their value to the user. For a copy write **Chain Belt Co., 1600 W. Bruce St., Milwaukee 4, Wis.**

JOISTS—A 12-page 2-color pamphlet lists a wide range of standard joists with spans varying from 25 to 72 ft and with loading capacities of 200 to 700 lb per lineal foot. Special features are listed in detail. A uniform load table, basic and special joist designs, as well as specifications and pictures are included in the booklet. Your copy may be obtained by writing to **Mr. J. S. Walsh, Sales Development Mgr., Dominion Bridge Co., Ltd., Lachine, Quebec, Canada.**

PORTABLE AIR COMPRESSOR—A Bulletin descriptive of its new 60 cfm Super Chief portable compressor has just been released. This lists all features of the Model 60-WBD, a new low-priced machine which the manufacturer claims is the lightest in weight, most economical operating compressor available today. Bulletin photos show the Super Chief in action. Compressor specifications are listed in detail. Ask for Form E-233. **Davey Compressor Co., Kent, Ohio.**

BUILDING PANELS—are described in a 38-page 2-color catalog entitled "Fenestra Steel & Aluminum Building Panels." Described in detail, besides these principal panels, are acoustically-treated panels, Holorib steel deck for roof spans up to 8 ft 6 in., loading tables, acoustic roof and reinforcing floor forms, together with 13 pages of detail drawings, fire resistance ratings, methods of panel electrification, panel selection tables and specifications. **Detroit Steel Products Co., 3139 Griffin St., Detroit 11, Mich.**

VALVE SELECTION CHART—A handy reducing valve selection chart is available to anyone who has to specify valves occasionally and who does not have all the engineering background necessary to do the job easily. Used in conjunction with Klipfel Reducing Valve Bulletin No. 148, the chart also helps determine proper sizes of valves. The chart clearly indicates which valves are suitable for dead-end service and which are not. Copies of the valve selection chart and Reducing Valve Bulletin No. 148 are available from **Klipfel Valves, Inc., Div. of Hamilton-Thomas Corp., Hamilton, Ohio.**

PROCEEDINGS PAPERS
AVAILABLE AS SEPARATES

THE FOLLOWING PAPERS, to be printed as Separates, are now subject to advance orders, based on the summaries here given. Discussion of these papers will be received as in the past. A summary of each paper will appear in three consecutive issues of CIVIL ENGINEERING, and papers will be mailed soon after returns give an indication of the number to be printed. Abstracts of other papers will be added every month to the list of Separates available.

1. **Improvements at the Back River Sewage Works, Baltimore, Md.,** by C. E. Keefer, M. ASCE.

2. **Public Utility Condemnation Cases in the State of Washington** by Henry L. Gray, M. ASCE.

3. **Treatment of Foundations of Large Dams by Grouting Methods** by A. W. Simonds, M. ASCE, Fred H. Lippold, M. ASCE, and R. E. Keim, Assoc. M. ASCE.

4. **Capillary Phenomena in Cohesionless Soils** by T. William Lambe, Jun. ASCE.

5. **Elastic Restraint Equations for Semi-Rigid Connections** by J. E. Lothers, M. ASCE.

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10. **Pollution Abatement Policy** by Thomas R. Camp, M. ASCE.

11. **Long-Term Storage Capacity of Reservoirs** by H. E. Hurst. To enable the Nile to be fully used for irrigation in Egypt and the Sudan, large storage reservoirs in Lake Victoria and Lake Albert will store water over long periods, equalizing the flow of the White Nile even through low years. For determining the storage required to guarantee a given draft, long-term records of many phenomena have been analyzed, including rainfall, river discharges, the annual growth of the big California trees, and the annual deposits of mud in lakes. The analysis brings out the difference between natural phenomena and chance events. (Available May 1.)

12. **Influence Charts for Concrete Pavements** by Gerald Pickett and Gordon K. Ray, Jun. ASCE. Using special charts it is easy to obtain theoretical deflections and stresses within a pavement slab regardless of the distribution of loading. For example, for an airplane landing gear with twin wheels in tandem, the imprint of the tires is drawn on transparent paper to a scale that depends on the slab and its supporting subgrade. The drawing is then placed on the appropriate chart in the proper position and data are taken directly from the area covered. The basis for the charts is given. (Available May 1.)

13. **Reinforced Concrete Skewed Rigid-Frame and Arch Bridges** by Maurice Barron, M. ASCE. This original presentation permits analysis and design that indicate the effect of skew on a barrel arch or rigid frame. Thus the skew problem resolves into a sort of secondary stress analysis, the ordinary stresses for a rectangular structure being considered primary. Then in the final design steel reinforcement and unit stresses are considered as functions of the similar rectangular elements. Equations and transformations are derived for all applied loads and for volume changes; and a test evaluates the importance of the skew effects. (Available May 1.)

14. **Mathematical Analysis of an Aerial Survey** by Lo-Ho. In the comparatively brief time since geodetic engineers and surveyors have taken to the air for blanket solutions of their problems, the explorers in this field have become identified in two categories—those who like to reduce their "notes" by instruments (stereometric topographic mapping) and those who place a greater reliance and emphasis on analytical analysis (analytical photogrammetry). Professor Lo-Ho stakes his claim in the latter field, and offers for discussion a procedure for the application of least squares to the successive correction of observations resulting from his system of aerial triangulation. A special feature of the paper is the author's statement of condition equations using the direction-cosine principles of space geometry. (Available May 1.)

15. **Computation of Equitable Charges for Treatment of Municipal Sewage** by Ellis E. Bankson, M. ASCE. It is hoped that, by discussion of this paper, a sound basis may be established for adopting rate schedules for sewage service. Such a schedule should include the special and unique cost features of ground-water infiltration (which are about equal to the cost of domestic flow, at nearly 30 gal per capita per day). Provision for daily peak flow produces a spread of equitable charges, in this case, from 18 cents per thousand gal to 7 cents per thousand gal. Modern needs of high specialization take into account a difference between frugal and unrestricted home use, as well as the difference between the use recorded by individual water meters and a master meter for a housing project. (Available May 1.)

D-VII Discussion of Paper, **Deflection of Plywood Beams Due to Moisture Content Change,** by W. E. Wilson and Laurence G. Olson. The original paper, published in the April 1949 PROCEEDINGS (p. 429), explores the reasons for the deformation of long floor panels of plywood box girder construction. M. W. Jackson, assistant professor of civil engineering at Georgia Institute of Technology, has discussed the internal stresses in a piece of plywood subject to variations in moisture content, and the authors have closed the discussion with a brief reply to Professor Jackson. These discussions only are included in Separate D-VII, to supplement the main paper. (Available May 1.)

16. **Pavement Bearing Capacity Computed by Theory of Layered Systems** by Guthlac Wilson, M. ASCE, and G. M. J. Williams, Jun. ASCE. A new method, based on the theory of elastic layered systems, for estimating the bearing capacity of road and airfield pavements, is described in this paper. It is applicable to both rigid and flexible pavements. All the important properties of the materials comprising the pavement and subgrade can be taken into account including pre-existing stresses in the subgrade. Charts are obtained from which the required pavement thickness can be read directly, if the loading and the physical properties of the subgrade and pavement are known. The more commonly used methods for computing pavement thicknesses are discussed and compared, particularly in so far as they permit consideration of the various factors entering the problem. (Available June 1.)

17. **Origin and Significance of Openwork Gravel** by Allen S. Cary, Assoc. M. ASCE. Stream deposits of "openwork" pebbles and boulders without interstitial sand were re-

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sponsible for leakage which led to the failure of the Cedar Reservoir in Washington. The very common occurrence of "openwork" gravel in the Pacific Northwest led to a study of its origin, distribution, and effect on the design of dams, levees, and other works involving water. The right abutment of the Chief Joseph Dam on the Columbia River in Washington consists of a 100-ft-thick bed of extremely pervious openwork gravel resting on bedrock 20 ft below river level and overlain by a very dense impervious bed of glacial till hardpan. The high permeability and the poor grading of the gravel pose a difficult problem of unwatering the right abutment during construction and of controlling seepage after completion. (Available June 1.)

18. Successive Approximations for Beams on an Elastic Foundation by E. P. Popov, Assoc. M. ASCE. A general method for solving problems of beams on an elastic foundation is given in this paper. Complex problems with variable moment of inertia of the beam and variable foundation modulus can be solved with relative ease by the proposed method. The procedures used are simple and are based on the well known moment-area or conjugate beam method of analysis. The difficult mathematics that occur in the usual solution of such problems are completely avoided. The proposed method should find practical applications in structural and foundation work. Even junior members of the profession can master the method quickly. Detailed examples solved in the paper illustrate the method. (Available June 1.)

19. Flood-Control Operation of Tennessee Valley Authority Reservoirs by Edward J. Rutter, M. ASCE. After engineering projects are completed, it is always of great interest to know whether or not they will function as planned. In the case of flood-storage reservoirs, it may be many years before a flood occurs which is large enough to test the planned operations. Recent floods in 1946, 1947, and 1948 provided such a test for the large system of reservoirs constructed by the Tennessee Valley Authority. Actual operations of the tributary and main Tennessee River reservoirs during those floods are described, and comparisons of actual flows with computed natural flows are shown in tabulations of crests and by graphs. Comparisons with hypothetical "fixed rule" and "ideal" operations are made to determine the efficiency of the actual operations. The paper also discusses the effect of tributary reservoirs and main-river reservoirs considered as groups. (Available June 1.)

20. Three-Dimensional Displacement Diagrams for Space Frame Structures by Walter Worthington Ewell, Jun. ASCE. The Williot-Mohr displacement diagram is an invaluable aid in the analysis of planar structures—yielding intrinsically important joint displacements, facilitating the construction of influence lines for redundant elements, and simplifying the calculations of secondary stresses in trusses. The space displacement diagram developed in this paper determines the movements of space frame joints along the three coordinate axes of space and lends itself to applications similar to those realized with the planar Williot-Mohr diagram. Three-dimensional displacement diagrams are presented for a simple space pedestal and for a second-degree indeterminate space truss. The graphical examples are illustrated progressively in three separate phases to clarify all construction principles, including the use of a rotational correction diagram. (Available June 1.)

21. Maximum Load Capacity of Bailey Bridges by Robert B. Stegmaier, Jr., Jun. ASCE. Structural sections for standard Bailey bridges were made in large quantities during World War II, by mass production. In military situations, where a bridge was already in place, it was important to know the maximum load capacity so that any necessary added strength could be provided by the most efficient use of available bridging materials. The paper describes the application of test results obtained by loading prototype bridges to failure. Three types of maximum load were established for each type and span of bridge, based on traffic regulations: For control, caution, and risk crossings. For control crossings traffic regulations were liberal. Risk crossings were closely regulated because of the more immediate possibility of failure. The departure from the normal analytical methods for the determination of highway bridge capacity is unusual. The methods described could be applied to any standardized structure. (Available June 1.)

22. Specifications for Heavy Duty Structures of High-Strength Aluminum Alloy, Progress Report of the Committee of the ASCE Structural Division on Design in Lightweight Structural Alloys. These specifications cover allowable stresses, design rules, and fabricating procedures for riveted heavy-duty structures built of the high-strength aluminum alloy known commercially as 14S-T6. The basic allowable tensile working stress is 22,000 lb per sq in. based on a minimum yield strength of 53,000 lb per sq in. and a minimum tensile strength of 60,000 lb per sq in. The manuscript for the specifications has been approved by the Executive Committee of the Structural Division. (Available June 1.)

23. Influence of Heavy Loads on Pavement Design Trends by K. B. Woods, M. ASCE. Data for this paper were obtained from a review of the literature and are evaluated in the light of research at Purdue University in West Lafayette, Ind., on soils, climate, traffic, and materials, since these variables relate to the performance of pavements in primary roads. Emphasis is placed on structural failures of rigid pavements and the rutting of flexible pavements. It is concluded that maximum-weight requirements must be strictly enforced, that the prevailing legal axle-load limits must not be increased, and that large-scale research must be initiated to study the economical design of the truck-pavement combination. Research is also needed to develop better methods of compacting base course materials for flexible pavements; and experimental work is necessary to evaluate the use of thick slabs with heavy reinforcement or the use of slabs with commonly employed thicknesses, constructed with various types and thicknesses of base course. (Available June 1.)

24. Summary of Buckling of Rigid-Jointed Plane Trusses by N. J. Hoff, Bruno A. Boley, S. V. Nardo, and Sara Kaufman. It is known that the buckling load of a compression member of a framework depends largely on the elastic restraint provided by the adjacent members. Recent investigations have shown that the restraining effect can be calculated rigorously. It is demonstrated that the rigidity of the gusset plates results in a sizable increase in the buckling load. The magnitude of the gusset plate effect can be determined with the aid of the diagrams presented in this paper. Experiments are described corroborating the theoretical conclusions. (Available June 1.)

25. Uplift Pressures in Concrete Dams by Kenneth B. Keener, M. ASCE. Measurements of uplift pressures in concrete dams, including analysis and keeping of complete records, are justified. A thorough description is given of the installation and location of equipment used in observing uplift. Methods of relieving excessive foundation uplift pressures are cited. A case history of the uplift at Hoover Dam is included, both prior to and after measures were undertaken to reduce foundation pressures. Results of long-time observations at other dams constructed by the Bureau of Reclamation are indicated. It is concluded that design assumptions for uplift more in keeping with actual observations would result in smaller transverse cross sections and thereby in an appreciable reduction in cost of concrete dams. (Available June 1.)

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